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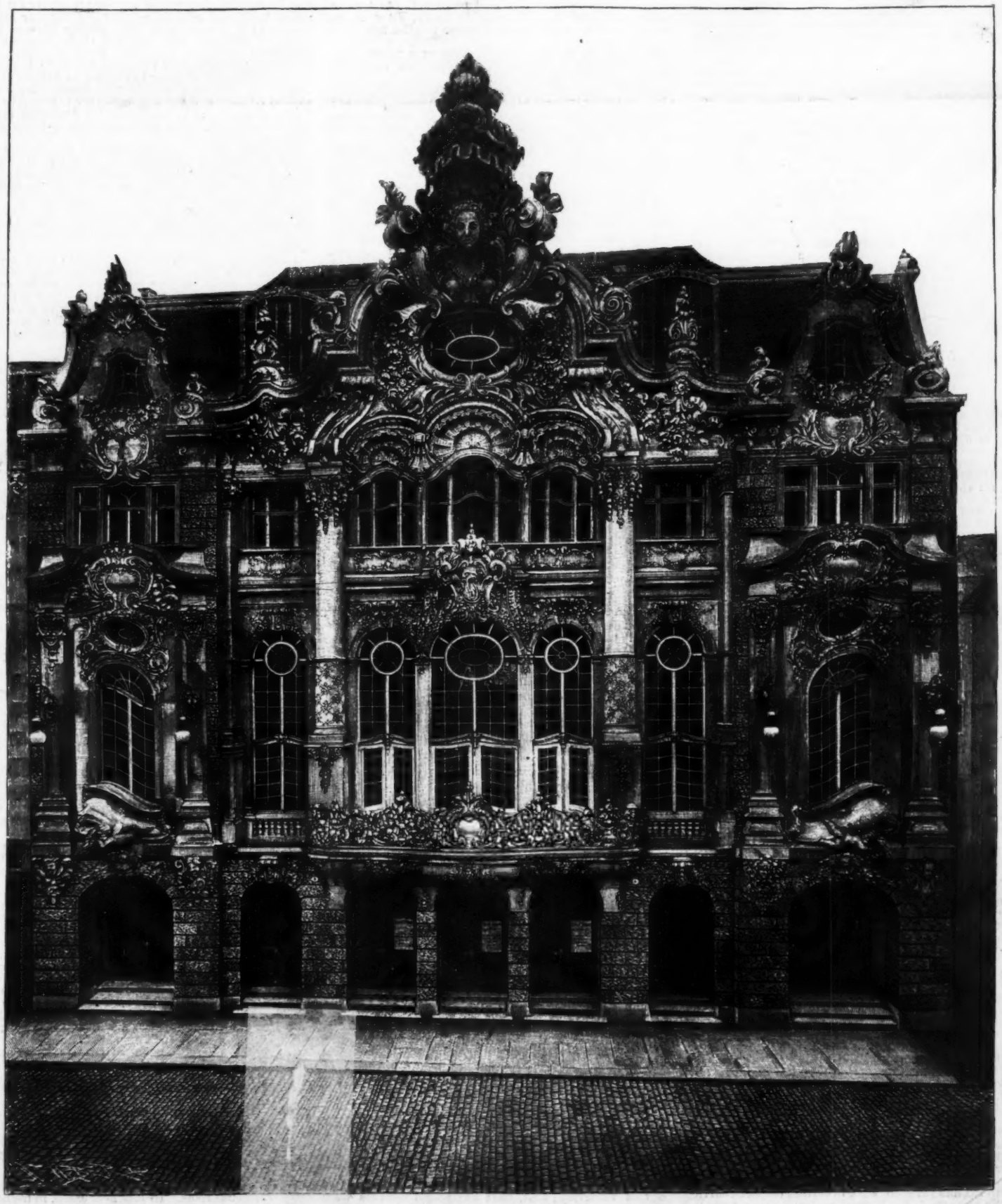


THE NEW CENTRAL THEATER OF DRESDEN.

DRESDEN'S NEWEST THEATER.

LAST year the city of Dresden saw the opening of a new variety theater, the magnificence of whose decoration cannot readily be equaled. The theater is remarkable in more than one respect. The baroque façade is almost too richly ornamented; but, despite the superabundance of decoration, architectural unity has been preserved. The foyer, the two-storied auditorium above it, the staircases to the right and to the left, the living rooms and studios in the upper stories —all are well proportioned and arranged.

Passing through one of the seven entrances, we first traverse the foyer, with box-offices to the right and to the left; then walking down the semicircular passage which surrounds the auditorium and ends at the stage, we pass into the auditorium through one of the many doors. The auditorium is 26 m. (85·28 feet) broad, 17 m. (65·76 feet) high, and 32 m. (104·96) feet long. Despite its size, the barn-like appearance common to most interiors of such vastness has been avoided. For this reason alone the architect deserves no little credit.

The color scheme of the auditorium is unique in its way. The predominating tint is green. Beginning in the parquet with a deep, fir-green, the color shades off upwardly into a soft sea-green. With this green background, the delicate coloring of the tiers, the rich gilding, and the shell-colored curtains in the second tier of boxes, harmonize excellently. The gorgeous coloring of the ceiling frescoes completes the effect of the whole.

The problem of lighting the building has been very practically solved. The electric light fixtures of the tier-railings, which in most German theaters obstruct the view of the stage and disturb the architectural effect, are here placed under the central arches, so that a much better impression is produced. These lights, in addition to the magnificent chandelier, whose two hundred and fifty-five jets are reflected many thousand fold by the mirrors on the walls of the second tier of boxes, illuminate the interior with a dazzling brilliancy that admirably displays the coloring of the decorations.

Of the two thousand seats in the house, there are only four from which the stage cannot be fully seen, a result obtained by the adoption of the horseshoe arrangement of balconies and boxes, and by making the partition walls in the various divisions as low as possible. Danger of fire has been reduced to a minimum by the use of fireproof materials in the construction of the tiers, walls, and ceilings, only the floors being made of wood.—Illustrirte Zeitung.

GREEK ARCHITECTURE—THE LIGHTING OF TEMPLES.*

YOU heard C. Garnier's opinion on the advantages of restoration as being one of the best methods of exercising the student's brains, by comparing, reasoning, and trying to find out, and so fitting him to use those qualities which are most necessary in actual practice; and though he spoke of restoration from the actual measurements of ruins and fragments, these qualities can be nearly as well exercised by the solution of problems, all the data for which have been measured for us; in one or two respects only do the measured data fall short of the original; they do not admit of the close study of the fragments themselves, which then may deliver up their secrets to him, and they lack the stimulating effects produced by handling the very pieces on which the ancient architects have bestowed their thought, and the workmen their care and skill.

The solution of the problem of the lighting of the Greek temples, up to a comparatively late period, was simplicity itself. If the temple had no windows, and was supposed to be too large to be lit by the door, it was said to be "hypæthral" in the modern sense of the word, that is to say, the restorers took the roof off the nave. I must confess that this appeared to me to be a curious expedient, even when I was a lad. The interior of the naos, with its idol and works of art, were then too much like the "Groves of Blarney":

> "There were all the heathen gods and goddesses so fair,
> There was Juno and Venus and bould Nicodemus,
> All standing naked in the open air."

And when I read of the statues being of ivory and gold, it seemed still more curious; still as I was told by my betters that there was no doubt about it that the Greeks could not truss a beam, and had no timber long enough without, and were unacquainted with the arch, I supposed the nave was covered with an awning, and that little or no rain fell—for aught I knew the climate was like that of Egypt.

Nicholson's and Sir William Chambers' "Architecture," "Rickman," and the "Glossary of 1838," "Bartholomew's Specifications," and a price book were then thought a fair library for an architect's office. Books were rare and costly; men worked for longer hours, and often spent their evenings for months gratuitously on office work; money was scarce; means of locomotion were rarer and much dearer than they are now; and there was no splendid architectural library like that of the R.I.B.A. open to all comers, so it was not easy to correct one's misconceptions. If any of you want to realize the climate of Greece in the winter, I recommend you to read Thucydides' account of the night escape of the 212 Platæans from their beleaguered city, and you will fancy it was a bad storm in England. In Thucydides you will read of rain, hail, ice, and snow, howling winds, lightning, and thunder. Consider the effect of a tempest like this on the most superb works of art the world has ever seen—made, too, of ivory and gold, enriched with gems, and adorned with painting and colors. Consider how agreeable it must have been to the priests to officiate in the open air, and to the crowds of worshipers; and on the other hand, remember that the Greeks who had adopted this very primitive method of lighting, i. e., taking the roof off their temples—an expedient below the intelligence of a North American savage—were the most brilliant race the world has yet seen, who, in certain respects, carried all the fine arts to the highest perfection they have yet attained.

Hume very justly says, "The same age which produces great philosophers and politicians, renowned generals and poets, usually abounds with skillful weavers and ship carpenters. We cannot naturally expect that a piece of woolen cloth will be brought to perfection in a nation which is ignorant of astronomy, or where ethics are neglected."

Even if we did not know it as a fact, we might reasonably suppose a people who excelled in all the higher arts were not entirely ignorant of the lower ones. If anyone in the present day wanted a village carpenter to put him up a one-story wooden house, with an open shed all round it, and said he could not have windows in the walls nor glass used, but he wanted a good light in the house, which was to be filled with pictures and painted statues, do you think he would consider the carpenter had much intelligence if he saw no other way of lighting it than taking the roof off? Yet but a few years ago we were seriously asked to believe that the Greeks could only solve the problem in this way. This state of things was brought about partly by ignorance, partly by what I may call an insane worship of the classics, particularly of the Latin ones. Only let a statement be made, or, as in this case, be supposed to be made, by a reputable Roman author, and it was swallowed whole; the very fact of its being impossible was the best ground for belief. As I have before said, and you all probably know, Vitruvius is the first writer on architecture whose treatise has come down to us.

Vitruvius, in Book I., cap. 2, gives us a reason why certain temples should be in the open air, or hypæthral:

"When buildings are dedicated to Jove, to lightning, to the heavens, to the sun, to the moon, they are erected hypæthral—in the open air. For of these deities we see both the appearances and the works when we are in the open shining face of nature."

Pausanias tells us that at Megara, in the Citadel, there is a roofless temple of Dusty Zeus; and by this I understand he means so built, for, further on, when he explains that Megara had two Citadels, he says, but if you descend to the haven which at present is called Nisæa, we come to a sanctuary of Molophorian Demeter, we may infer that the roof of the sanctuary has fallen in through the effects of time. (Attic., cap. 44.)

Although a lecture is the worst possible method of discussing controversial questions, I must ask you to bear the reading over three times of a part of the translation of the five and a half lines of Vitruvius (Lib. 3, cap. 2, par. 8) from the three English translations of Newton, Wilkins, and Gwilt, published respectively in 1791, 1812, and 1826, and I beg you to note down particularly the last sentence.

Newton says: "Hypæthros is decastyle both in the pronaos and posticum; in all other respects it is the same as dipteros, except that in the inner part also it has columns—two rows in the height, detached from the walls all round, like the peristyle of a portico. Also the middle part is left uncovered, and without a roof, and doors open both to the pronaos and to the posticum. Of this there is no example in Rome; but such is at Athens the octastyle temple and that of Jupiter Olympius." (Newton's "Vitruvius," Book 3, cap. 1, par. 8.)

I must here remark that the translation, "like the peristyle of a portico," does not appear to me to be a correct translation of "ut porticus peristyliorum," nor does it convey any meaning to me. Wilkins left it out, and Gwilt puts it in the plural, but "the portico of a peristyle" is to me perfectly clear, for the English equivalent of peristylium = a place surrounded with columns on the inside.

Wilkins says: "There is no temple of this description at Rome, but there is one at Athens, within the city, dedicated to Jupiter Olympius." (Wilkins' "Vitruvius," Lib. 3, cap. 1.)

Gwilt says: "Of this sort there is no example at Rome, there is however an octastyle specimen of it at Athens, the Temple of Jupiter Olympius." ("Vitruvius," Lib. 3, cap. 1, Gwilt's.)

I shall not further attempt to compare their translations with the published Latin text, for it is evident that the first and last were most careful and conscientious men who were conversant with the various editions and translations published before their time, and were architects.

The great Wilkins was not only an architect, but also a Fellow of Gonville and Caius College, Cambridge, and had consulted the MSS. as well, and had sufficient belief in his own scholarship to amend the printed text.

On the supposition that the scribe who wrote octastylon ought to have written in "In asty Jovis," he gives the English equivalent of his own emendation, and if his knowledge and judgment could have been depended on, it would have removed a cause of controversy, and acquitted Vitruvius of what seemed an error we thought he might have avoided.

Vitruvius says: "Of this, however, there is no example at Rome, but at Athens an octastyle in the Olympic temple;" the controversy was whether by the octastyle he did not mean the Parthenon, as Jupiter Olympius was always believed to be decastyle, and the supposed error was this, that if the "and" was "is," then if Jupiter Olympius was decastyle, that he ought to have known it.

In the Hellenic Society's Journal of 1888, the result of Mr. Penrose's observations on the Temple of Jupiter Olympius is given as follows:

"Some excavations for the purpose of determining the plan of the temple itself have been carried on by the Society of Dilettanti under my direction, and have resulted in proving that the temple was octastyle, instead of decastyle, as generally supposed. The foundations have been much uprooted by searches for building stone in past times, but amply sufficient has been found for recovering the complete plan of Antiochus' temple and also some interesting particulars respecting the earlier foundation."

These earlier foundations are those of the temple begun by Pisistratus.

You have now all the information that is to be got out of Vitruvius; first, that hypæthral temples were decastyle, and that the temple of Jupiter Olympius at Athens was an example of an hypæthral temple, though octastyle (built as you doubtless recollect for Antiochus Epiphanes by Cossutius, an architect and Roman citizen, between 175 and 164 B. C.), and that hypæthral temples were besides confined to the following five deities: Jove, lightning, the heavens, the sun, and the moon. There are a few remarks by Greek writers on this subject which I shall presently mention.

The only decastyle temple whose ruins have come down to us is that of Apollo Didymæus, at Miletus. The dodecastyle one of Demeter and Persephone at Eleusis, which, Vitruvius informs us, was so built without a portico by Ictinus, may therefore, I think, be put aside. Apollo Didymæus, according to Gandy, is 75 feet 3 inches across between the pilasters of the naos; and, according to Strabo (Lib. 14, cap. 1, section 5), remained without a roof, on account of its magnitude; consequently, we have it from necessity as one, I might say the one, temple that was decastyle, and without a roof, from which Vitruvius deduced his rule. We have now only left the octastyle Temple of Jupiter Olympius at Athens (built by the Roman architect) that Vitruvius says conformed to the rule he deduced from the one temple they could not roof, and I presume this was rather from want of means than from want of skill. The question is whether Jupiter Olympius at Athens was ever finished in Greek times; the Romans were always rather chary of destroying temples. A story is told in Plutarch of a temple being pulled down and brought to Rome, and the Senate ordered it to be taken back and rebuilt, as they did not war against the gods; it was covered with marble tiles so fitted that the Romans could not put them up again, and merely left them on the spot. Sulla, who died in 78 B. C., or two years after Vitruvius was born, took some of the columns of Jupiter Olympius at Athens for the Temple of Jupiter Capitolinus at Rome after he had sacked Athens, and those columns are believed to have been the inside ones. In the time of Augustus, according to Suetonius, there was a conclave of kings about finishing this temple.

Pausanias (Lib. 1, cap. 13) says the temple was dedicated by Hadrian (probably about 130 A. D.); therefore, as far as this temple is concerned, it was hypæthral like the other, because it could not be finished, and even if at its rebuilding by Cossutius it could be considered as Greek, it was certainly not so when it was finished by Hadrian. So our hypæthral temples, on account of their size and disposition, have vanished into thin air.

I want you to notice this argument; if all temples were lit by a hypæthros, or were unroofed, it would have been much simpler for Vitruvius to say so, and not to have mentioned his five deities and given the reason why their temples should be open or hypæthral; so that I think we may fairly conclude that other temples were neither without a roof nor with a hypæthros.

We will admit, then, that temples to any of the five deities before mentioned must be without roofs, or have an hypæthros; let us begin with those of Jupiter and see what we can learn about them.

That temples to Jupiter were roofed we have on the authority of Strabo, who, speaking of that of Zeus Olympios at Elis, says: "Of the offerings, the largest was a statue of Jupiter in ivory, the workmanship of Phidias, of Athens, the son of Charmides. Its height was so great that, although the temple is very large, the artist seems to have mistaken its proportions, and although he made the figure sitting, yet the head nearly touches the roof and presents the appearance that if it should rise and stand upright it would unroof the temple." (Strabo, Lib. 8, cap. 3.)

Pausanias (Lib. 5, cap. 10) describes the same temple, and, speaking of the inside, says: "In this part the top of the temple contracts itself;" and further on, "Within the temple there are pillars which sustain porches at a considerable height from the ground" (probably the internal peristyles and galleries). "Through these there is a passage to the statue of Jupiter, and they afford a winding entrance to the roof of the temple."

In the temple of Jupiter Panhellenius at Ægina, the late Prof. Cockerell found a piece of the coping of an hypæthros, for in it were the housings for the ends of the tiles and their cappings; and W. Kinnaird shows the top of a tomb from the island of Rhenea, the cemetery of Delos, in imitation of the roof of a temple, where a double barreled hypæthros is shown, the length of the two together being a trifle less than one-third of the whole length, and a trifle more than one-third of the width.

Prof. Cockerell also mentions the representation of a temple cut on a rock at Cyrene, a sketch of which is given in Capt. Beechy's travels, which seems to show a large hypæthros, half the length of the temple, which stands up above the ridge and has no openings in its side.

Vitruvius (Lib. 1, cap. 2) says: "Temples of the Doric order are erected to Minerva, Mars, and Hercules; the Corinthian order is more appropriate to Venus, Flora, Proserpine, and to the nymphs of fountains; that of the Ionic to Juno, Diana and Bacchus, and other similar deities." The question for us now is whether we can class Apollo with Minerva, Mars, and Hercules, or with Juno, Diana, and Bacchus, or whether we must consider him as typifying the sun god. At Bassæ he is called "Apollo the Helper," because the cessation of an epidemic was attributed to his influence, and he is lodged in a temple, Doric externally; so that it is not as the sun deity that he is there worshiped. Baron Haller, who was one of the party at Phigalia in 1811 and 1812 with Prof. Cockerell, found among the ruins two marble tiles with the center part cut out, and the angle next the opening rounded. Prof. Cockerell concluded that this was another form of a central hypæthros. I believe the particulars of these tiles were not generally known until Prof. Cockerell's book on Ægina and Bassæ was published in 1860.

In the fourth or supplementary volume to Stuart & Revett's "Athens," published in 1830, Prof. Donaldson gave a plan of this temple, and a section through the opisthodomos, the inner chamber, and a part of the naos, showing it without a roof, and in the French scientific expedition to the Morea, M. Blouet also showed the naos open, but with some slight differences in the contiguous roofs. In 1849 Fergusson, in his book of the "Principles of Beauty in Art," suggested a clear-story, lit by holes sunk in the roof. The late J. W. Papworth studied the whole question minutely, and gave the results in a paper read before the Royal

* Prof. Aitchison's sixth and concluding Royal Academy lecture, delivered on Thursday, February 16.—From The Builder.

Institute of British Architects in 1866, and showed from the fragments of the tiles that they must have accorded with Fergusson's plan, as they had a stop for the water next the opening, and a gutter to catch the rain coming from the ridge of the roof, and to convey it down the side; and he also found in the British Museum another sarcophagus from Crete, whose top represented the roof of a temple with two of these sunk holes, one at one end and the other at the other, but on alternate sides of the ridge.

M. Charles Chipiez published in the Revue Archeologique, 1878, a memoir on the hypæthral temple. He there gives a view of his own, viz., that in those temples that have internal aisles of two stories, the floor of the gallery was a stone roof open to the air, and that the curb of the hypæthros found by Prof. Cockerell at Jupiter Panhellenius at Ægina was that of one of the lower sides; he accepts Fergusson's two long slits in the roof, allows the rain water to escape therefrom through the walls of the naos onto the peristyle pavement. In his illustrations he has decorated the outside of the naos walls with what look like breast plates, which may be a sort of water guard, but without pipes—the scale of the illustrations is too small to give a definite opinion—and he also suggests that in some cases the wet that fell might have no outlet for escape, but be allowed to evaporate. The argument he brings in favor of this, in the case of Jupiter Panhellenius at Ægina, is the fact that C. Garnier, when he restored this temple, found that the arrises of the flutes of the upper columns were painted red, while the lower ones were uncolored. I give you his words: "An observation made at Ægina, by M. Garnier, on the same edifice we have reproduced, renders the existence of two openings in the roof very probable. This observation has been directed to the lower and upper columns of the naos. The former are monochrome, while the clear and uniform tone of the latter is violently relieved by lines of bright red which mark the arrises of the flutes; if one turns to the perspective we give, it will be seen that it would be absolutely necessary that it should be so. The columns, lit by the cross lights, would only offer to the spectator placed in the axis of the temple a confused and indefinite outline, if some strongly marked lines did not re-establish the firmness of the outlines. This refined artifice is stamped with Greek subtlety, and thoroughly explains itself by a lighting from each side."

Another of his arguments is that there are no staircases to these galleries, which only amounts to this: that, apparently, there were no stone ones. He uses it to prove that they were not used by the general public who attended for worship, or for seeing the temple and its contents. M. Chipiez also points out what every architect must have observed in looking at the flank of a restored temple with the usual hypæthros, that the great notch cut out of the ridge, and extending for a considerable distance, is not merely inartistic, but very unsightly.

I believe this completes all we know from actual facts, and all that has as yet been found out from the testimony of the ancients, and we now come to Fergusson's theory.

There were no two more brilliant theorists than Viollet-le-Duc and Fergusson, and you cannot read the works of either without admiration; you often find that by their almost magical instincts they have turned darkness into light, and you feel that you get information, delight and that enthusiasm that genius communicates, from the perusal of their works; but you will also find that no sooner does a theory irradiate their minds than, like the sun, it blots out everything else, and that in many cases they have invented the very foundations of their hypotheses.

For instance, Viollet-le-Duc seems to prove incontestably that the dome of the Pantheon is in two thicknesses because the inside shell is coffered, and the outside one was composed of discharging arches, and says Piranesi saw the arches on the outside; but when you refer to Piranesi, you find he saw these arches on the inside; so when Fergusson says this is self-evident, and if you deny it, show how you can do it better, then beware, and weigh everything with the utmost care, and look up all the references.

As I said before, fact is stranger than fiction, and you must not allow yourselves to be carried away by mere probability. We know that some Greek temples had pediments, we see from Cyrene that in all probability the parapet of the hypæthros was sometimes carried above the roof, that by raising it a little and roofing it and putting in windows we should get a clearstory; or, by sloping the roof down to the bottom of the wall of the hypæthros and piercing it we should do the same. The question is whether the Greeks did either?

The Telamones at Jupiter Olympius at Acragas point to clearstory windows, but then this is one of the temples that, according to Vitruvius, must have a hypæthros. However, we need not trouble ourselves about that which was never done, for Diodorus Siculus (Lib. 13) tells us that "When the Agrigentines were on the point of putting on the roof, war interrupted their operations, and after that time the city was so far reduced in circumstances that they had no longer the means to finish it." If this part, where the Telamones or Atlases were, was pierced with windows, they probably would not have filled them in, but as yet I have seen no proof that they were ever open.

Perhaps the most interesting temple that remains to us, in plan only, is that of Demeter and Persephone at Eleusis. It is fitted with forty-two columns, according to the last plan published by Dr. Dörpfeld, and looks like the hypostyle hall at Karnak; it appears to have had seats all round the walls for spectators to witness the wonders shown during the initiation, but we can only surmise as to its lighting that it might have been lit like the Karnak hall.

Almost all we know about the temple of Demeter is from Strabo, Vitruvius, and Plutarch. In Book 9, cap. 1, section 12, Strabo says: "Next is the city of Eleusis, in which is the temple of Eleusinian Ceres, and the mystic inclosure (Σηκός) which Ictinus built, capable of containing the crowd of a theater. It was this person who built the Parthenon in the Acropolis in honor of Minerva, when Pericles was the superintendent of the public works."

Vitruvius says, speaking of marble temples (Lib. 7, Introduction): "The third is the Doric temple of Demeter and Persephone at Eleusis, the cell of which was built by Ictinus of extraordinary dimensions for the greater convenience of the sacrifices, and without any external colonnade. This structure, when Demetrius Phalereus (B. C. 317) governed Athens, was turned by Philus into a prostyle temple with columns in front, and by thus enlarging the vestibule, he not only provided accommodation for the novitiates, but gave great dignity to its appearance."

Pausanias (Lib. 1, cap. 38) tells us when speaking of this temple: "But I am forbid by a dream from relating the particulars within the sacred wall." Consequently we have unfortunately no information from this gossiping traveler that can throw any light on the subject. He certainly ought to have been put in the pound for straying; however, he seems to have been a careful observer, though evidently without much taste for architecture.

Plutarch, speaking of this temple, says: "Coroebus began the temple of initiation at Eleusis, but only lived to finish the lower rank of columns, with their architraves" (by which I presume he meant the inside order). "Metagenes, of the ward of Xypete, added the rest of the entablature; and Xenocles of Cholargus built the dome on the top." (Plutarch, "Pericles," Langhorne's Trans., London, 1801.)

Dome was their translation of opaion, which Fergusson considers was the clearstory; now, if the opaion was a mere hole, it seems hardly likely that a biographer would think it worth while to notice it and the architect who left it out.

Ὀπή=opee was the name for the smoke-hole of the original hut. Aristophanes in his "Wasps" uses the word in that sense. Bdelycleon confined his father Philocleon in the house, which he has also surrounded with guards to prevent his father from voting. Philocleon on getting out of this hole or chimney tells the guard, "I am smoke coming out." The word opee seems to have been used for a hole generally, as in metope, the hole between the triglyphs. Ὄκριον seems to mean a hole in the roof too, and if there were a clearstory, it might eventually have been applied to that.

The Temple of the Parthenon at Athens is one of the cases where the hypæthros is not required by "that which is established," according to Vitruvius; but we are certainly in greater darkness about its lighting than about that of the Temple of Demeter at Eleusis. We do know this last had an opaion, though we do not know exactly what an opaion was; but we do not know even so much about the Parthenon. All we know is this, that there is a coin which shows it perched on a rock, but there is no sign of a hypæthros on the temple.

Fergusson's theory as applied to any temple, not being one of the five deities specified, is unassailable by argument in the present state of our knowledge, though it may eventually turn out he was wrong. His opponents rely on Vitruvius; but in the case of the Parthenon the argument is against them, and there seems to me to be no choice between artificial light and his scheme of a clearstory, or M. Chipiez's that the upper gallery was the clearstory, except Dr. Dörpfeld's that it was only lit through the door. The artificial light theory is, I think, untenable, for this temple particularly required brilliant lighting; the idol here was not a fetish or a totem. It was one of the finest works of art in the world, of ivory and gold, and made by Phidias, who made the statue of Jupiter at Olympia, one of the seven wonders of the world. No more splendid effect of the idol can be imagined than its sudden irradiation by the rising sun. But besides the idol, the sculpture and painting of the temples themselves (the temples were museums of trophies of gorgeous armor, of painting, sculpture, and what we should now call objects of vertu and sacred relics). As the ancients could only light by torches, candles, and lamps without chimneys, every work of art would have been ruined with the droppings or the smoke, and Fergusson remarks, speaking of the frieze of the naos at Bassæ:

"Supposing the cell roofed in any way, every one must see that it is quite impossible that sculpture so placed could have been properly lighted by any artificial means, for in that case the lights must have been below the level of the figures; besides, no frieze can be properly lighted by artificial light unless it was in only one direction and was illuminated by one lamp of sufficient power to light up the whole. I need not say the Greeks could not command this; and I defy any one now, even with gas, and all the mechanical means we can command, to do this as it should be done. Nor need I add that the Greeks would never have placed such a work of art in a position where it must remain in the dark, or be lighted so as to make it literally ludicrous." The only thing to be said about this is that it might have been lit by reflected light like the Panathedaic frieze of the Parthenon.

Fergusson adopts the theory of the clearstory sunk in the roof, and showing on the outside either by two sunk holes or slits. You must recollect that the Parthenon roof could not be seen, but that at Bassæ could, for there is an adjacent mountain overlooking it. The two fragments of tiles at Bassæ show that there must have been one hole at least, but there is nothing to show it was not a hypæthros to light the sculpture of the nave; the statue of the god in the back chamber must have been simply lit by the east doorway; and all the argument against this is Pausanias' account of the dead soldier in the Heraion at Olympia (Lib. 5, cap. 20): "Aristarchus, the Olympic historian, relates . . . that in his time, when the Eleans were repairing the roof of the Temple of Here, between the polished part of the roof and that which supports the tiles, the dead body of a wounded man in armor was found. It appears to me that this man, having engaged in a fight against the Lacedæmonians, in the Altis, when the Eleans, in order to defend themselves, ascended to the temples of the gods and every place of eminence, then died, fighting in this place; and that his dead body remained so long entire because, being concealed in their retreats, it could neither receive any injury from hot vapors in summer nor from cold in winter." (Lib. 5, cap. 20.)

This amounts only to a strong probability. Another argument for it is this, that as yet no drainage under the naos of a temple has been found, though perhaps it has never been looked for.

Fergusson's scheme can no more be set aside on account of the difficulty of getting the water off than a scheme of the present day could be, because of the impossibility of draining an internal lead flat.

The Greeks could make tiles and troughs out of marble as well as of pottery, and could cast bronze better than we can now; it is therefore ridiculous to make such an objection, because no rain-water pipes have been found. As no fragments of earthenware pipes have been found there, we may safely say there were none; but metal was once so precious that it paid men to cut through stonework to get out the iron cramps and their lead fixings from the Colosseum.

What does tell against his theory, or that of a free clearstory, is that no fragments of one have been found; it is true they have never been looked for.

Even to the present day the bulk not only of the educated, but of architects themselves, are quite content with the open air theory.

Fergusson's suggestion that temples might be lit by a large window at the end of the naos, getting its light from an unroofed narthex or open court, or above a low closed one, is an admirable idea for present use, doubtless suggested to him by the Cave temples of India, and may well claim our respectful consideration, as we generally fritter our light away in imitation of mediæval times, having forgotten the reason of this plan being adopted, viz., that mediæval churches were designed as picture galleries of stained glass.

Mr. Penrose found in the Jupiter Olympius at Athens that there was a compartment at the east end, nearly corresponding with the opisthodomos at the west end, and that there was no sign of there having been columns in either, which he says "would have been exactly suited to the Fergussonian theory." There were no signs of internal drainage, but there was a complete drain all round the temple about 20 feet from the stylobate.

Fergusson, in his "Parthenon," constantly refers to Roman buildings as probably continuing the method of lighting pursued by the Greeks; there is, however, a strong probability that Roman buildings were lit by a hypæthros, probably covered with a skylight when glass or lapis specularis came to be generally used, as in the Thermæ at Pompeii.

The Pantheon at Rome is the one grand temple that has come down to us with a hypæthros, and it remains open to this day, the rain-water running down a gulley under the center of the eye. This is the most solemn, striking, and superb method of lighting that can be seen in Europe, and is worth a journey to Rome to see, and to receive its ineffaceable impression. The area of the eye is only about one twenty-eighth part of the whole area inside the circle of the floor, the only supplement it has, when the doors are shut, is the light that comes through the latticed bars of the fan light some 70 feet from the front of the portico.

If the nave of the Parthenon was lit by a hypæthros as shown by Mr. Falkener in his Dædalus, an opening 10 feet by 8 feet would have been sufficient to light the nave, if the Pantheon proportion be adhered to, for according to Stuart, it was but 68 feet 6 inches by 32 feet 6 inches; and there would have been a magnificent gloom behind the lower columns of the interior peristyle, cut off as the light would have been by the gallery floor.

There is one thing positively certain, that in the best ages of Greece, ample light was required for their temples.

In the little temple of Niké Ἄπτερος by the Propylæa, there are two windows about 3 feet 6 inches wide on either side of the central doorway, though the naos is but about 12 feet by 13 feet. Prof. Cockerell, in his book of the temple of Jupiter Olympius at Acragas, shows it lit all round with windows, and we have heard that it was never roofed.

Fergusson says that his clearstory plan was used at the Heraion at Olympia, and in a note he says:

"We are now proposing to erect a museum of casts. For this purpose we cannot do better than copy the interior of this temple. We may depend upon it the Greeks knew better than we do how their sculpture ought to be lighted, and we cannot do wrong in copying them as literally as possible. They are now erecting galleries for casts at Cambridge and I am not without hopes that one of them will be a copy of the interior of the Heraion, and that we may thus have an opportunity of judging of the effects of the Hermes placed and lighted as it was done by Praxiteles himself. ("Parthenon," page 88, footnote.)

A large hall surrounded by dead walls can only be lit in three ways: by a skylight, the hypæthros, by a lantern (for a clearstory is only a large lantern), or by artificial light; though some artists prefer a lantern, the bulk prefer a skylight.

We can only approximately try the effects of lighting for a special object by using models, and I strongly advocate your getting a rough model made of the Apollo Epicurius at Bassæ and trying the two plans, viz., with Fergusson's clearstory and with Prof. Cockerell's hypæthros, and seeing which lights the frieze best. A mere wooden box would do, if loose or hinged pieces were provided to cut off the light by the hypæthros when you were trying the clearstory, and vice versa.

If any important section of mankind are still anxious to solve the problem of the lighting of the Greek temples, and if architects will research the ruins and re-examine the fragments, and ascertain the method of drainage in the temples and immediately around the steps; if scholars will still search for passages relating to this subject in the well-known authors, and in others where such information has not hitherto been looked for; if men of taste and education will aid, and men of means will supply funds for this purpose, or if our government could be roused to lend its aid, I have no doubt this problem would be solved within a few years.

Translation of an extract from a Letter of Dr. Dörpfeld's, January 8, 1899.

"As to my opinion on the lighting of Greek temples, I have not changed it since I wrote an article on the hypæthral temples in our Athenian Journal of 1891, page 334.

"I do not believe that the Greek temples, at the Parthenon, for example, had any other lighting than came through the doorway. Why had the doorway of the Parthenon a height of 10 meters and a width of 5 meters (i. e., of 50 meters) if it were not for allowing

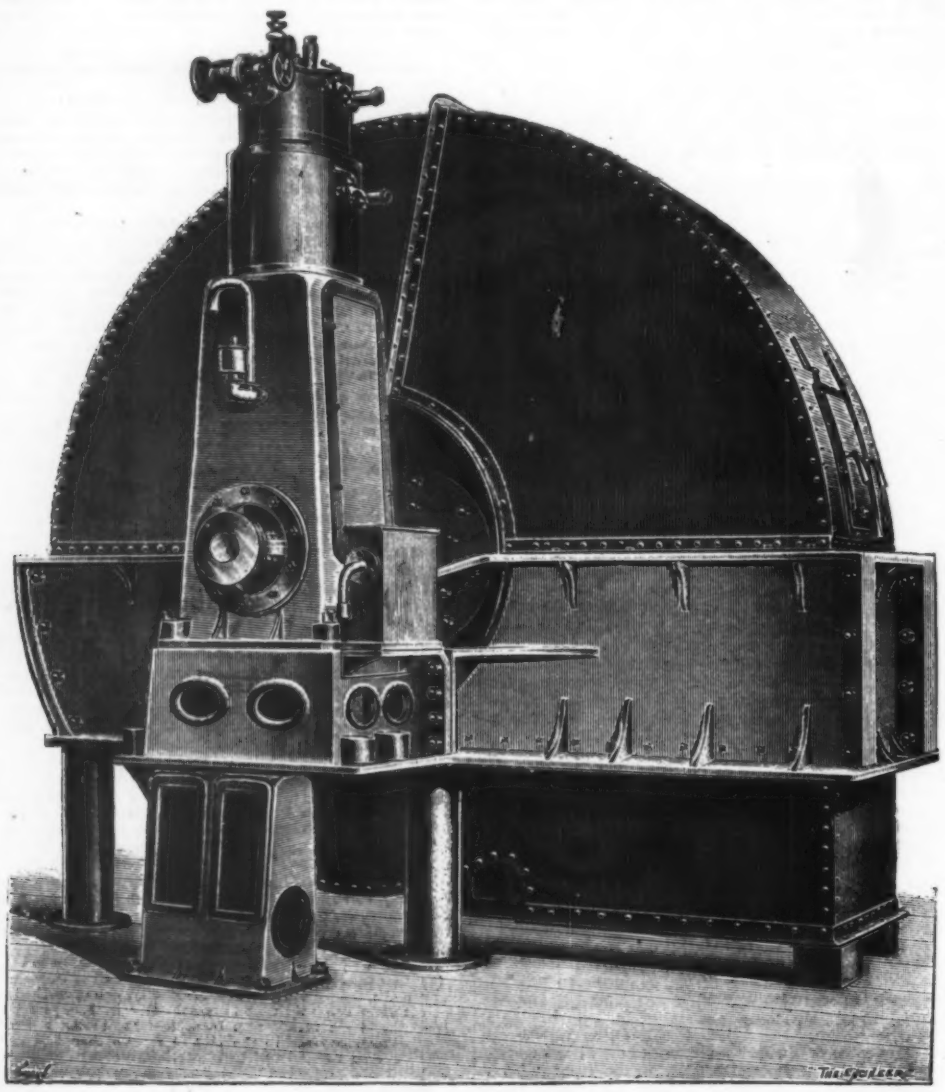
the light to enter the cella, and particularly to illuminate the statue of Athena? I am persuaded that this light perfectly sufficed. The temple at Bassæ was perhaps a hypæthral temple, because all the interior of the cella between the columns might have been without a roof.

"The statue of Apollo was, as you know, behind the column of the interior."

I must return my thanks to so many for the assistance they have lent me that I might almost fill one lecture with them. To Dr. A. S. Murray, to the Science and Art Department for Fergusson's model of the Parthenon, to Professor Smith for the favor of his diagrams, to the "Guardian" Fire Office for their chromo-lithograph, to Sir G. Grove, Mr. Holmes, Mr. Tadema, and a host of other private friends, for information, translations, books, and suggestions.

FAN AND ENGINE FOR FORCED DRAUGHT.

WE think, says London Engineer, the following particulars of a test of an engine and fan for supplying forced draught to the boilers of the "Belgia," a vessel lately completed by Messrs. Harland & Wolff, for the Hamburg-American line, will be found interesting. The plant was constructed by Messrs. Bumsted & Chandler, of Hednesford, and is illustrated below. It consists of a fan 78 inches in diameter, having air inlets on each side, and it discharges air downward into the stoke-holds. Its capacity is 30,000 cubic feet at 3 inches water pressure, but the indicator diagrams reproduced were taken with the fan mouth or discharge partly choked in order to obtain a high water pressure, increase the speed of rotation of the engine, and so make the test severe. The actual gage pressure was 6½ inches of water, the engine making 400 revolutions per minute, delivering 14,000 cubic feet of air per minute at a velocity of 9,816 feet per minute.



COMBINED FAN AND ENGINE.

The blades of the fan are flanged and riveted on to a steel disk—twelve blades each side of the center plate. This disk is turned true and bored to fit on to a center casting which is keyed on to the engine shaft, which is 3¼ inches diameter.

The outer end of the shaft is carried in a long white metal bearing, having oil rings to supply a constant stream of oil on to the fan shaft. The pistons are single acting, steam being taken on the top only, and a vacuum acting on the low pressure piston during the down stroke only. The indicator cards are taken from the small fan engines. Those taken from the larger type of engine illustrated show increased economy. Piston valves are employed, one high pressure and one low pressure to each cylinder, steam pressure acting on the top to keep a constant downward pressure on the eccentric; thus everything being in compression, the engine runs perfectly silent. Lubrication is effected by the "splash" system, the crank dipping into oil at every revolution and throwing it in abundance on to every working part. The power of each engine exhausting to atmosphere is 76 brake horse power, with 125 lb. steam at 425 revolutions per minute. Size of cylinders, 8 inches and 11 inches by 6 inches stroke.

NEEDED INVENTIONS.

By ROBERT GRIMSHAW.

ONE of the lessons taught by the battle of the Yalu, and by those of Manila and Cavite, has been pointed out by prominent British and American naval authorities. It is that wood must be largely abandoned in the construction of ships of war. It has been established beyond question that the large powder grains of modern days are driven, half-consumed, against all surrounding objects when a shell explodes, and if they strike ordinary woodwork they will partly penetrate it and will set it on fire. We don't need any especially inflammable material, as Greek fire—and if we used it, it would lessen the explosive power of the shell. A shell is shot for the purpose of doing all the damage possible. If it occasions torture instead of sudden death, it is a pity; if it sets a ship on fire instead of blowing it skyhigh, it is all one to the shooters. What we need, however, is a composition which will render wood fire-proof, without making it attack iron which is in contact therewith—as much of the recently vaunted "fireproof" wood did. A fireproof coating is no good against the penetration of half-burned and still burning powder-grains.

The exclusive use of iron, as advocated by constructors and combatants, is impracticable, for several reasons. In the first place, it greatly increases the "sweating." Covering ironwork with a dope of paint skins and cork chips is good enough for the cabins of merchant ships in hot climates, but is for warships of no use; the entire ceiling, sides and floor cannot be so treated. In the second place, quarters so treated in great surfaces would be uncomfortable or even untenable, and the comfort of officers and men is essential to their health and efficiency. In the third place, such a coating would not only be highly inflammable, but would generate noxious gases in burning.

Some one must get up a fireproof (and rot-proof) wood for sheathing ironwork, and for making partitions, floors, etc.

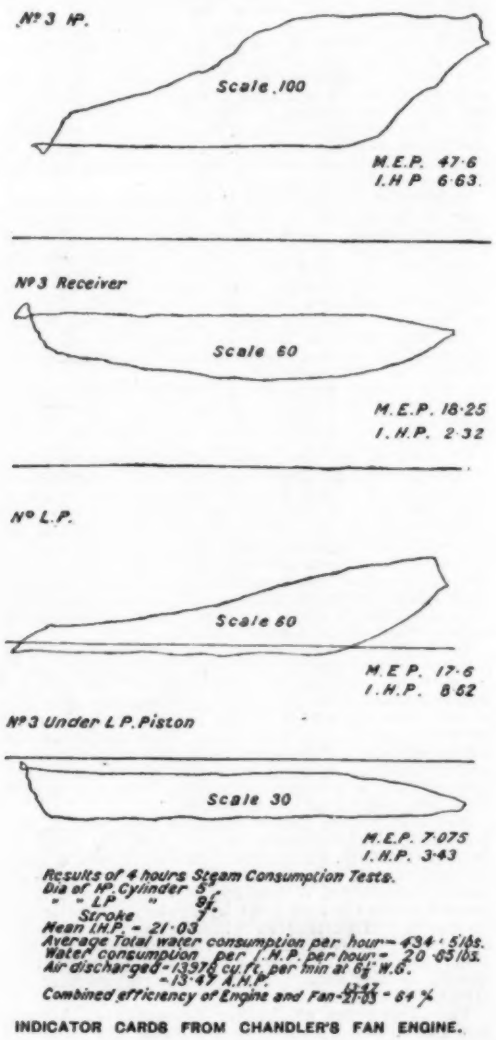
While on the shipbuilding question, the problem of water-tight doors in bulkheads comes up; these should be easily opened and shut, not only from their own place, but from on deck; and from each there should be an indicator which should show, on deck, whether they were open, shut, or half shut. This indicator should be of a character to sound an alarm when either the door opening and closing mechanism or the indicator itself is out of order.

The accident to the battleship "Iowa," while in the "hoodoo" dry dock No. 3, by which a whole compartment was filled with water to the depth of twelve feet, because a sea cock was left open, although its so-called "indicator" announced that it was closed, points to the necessity (1) of controlling indicators themselves, and (2) of having the condition of all sea cocks not only observable from the bridge or other conspicuous place above the water line, but controllable therefrom.

There is room for a very considerable improvement in boat-lowering devices for ocean steamers. They must be of a kind that will be absolutely uninjurable by storm (davits are often bent and rendered unserviceable) and must permit the boat to be lowered when full of passengers and provisions, and cast loose in the twinkling of an eye, and their lowering and casting loose must be effectable (if there is such a word) either from the deck of the vessel or from the boat itself, at will. As a matter of course, both ends of the boat must be cast loose at once. Davits work too slowly and uncertainly, and not easily enough.

There is also room for improvements in gun carriages for warships. The present contrivances permit racking the ship to pieces. They have not enough cushion. The amount of cushion must be controllable according to the amount and kind of powder; as a heavy charge requires more cushion than a light one, and slow-burning powder a more gradual increasing cushion than fast.

There is still room for the production of a cheap celluloid substance for the protection of warships from the entrance of water through shot holes. It is too much to expect that such cellulose shall stop projectiles; it must, however, so swell on the entrance of water in small quantity as to effectually limit the amount that does get in. Cocoanut fiber, maize stalk pith, and other substances, have been tried, but the bill seems not yet to be filled. The material must be cheap, light, compressible, highly absorbent of water, and susceptible of being made fireproof and rot-proof without materially affecting its other desirable qualities.


No 3 HP.
Scale .100
M.E.P. 47·6
I.H.P 6·63.
No 3 Receiver
Scale 60
M.E.P. 18·25
I.H.P. 2·32
No L.P.
Scale 60
M.E.P. 17·6
I.H.P. 8·62
No 3 Under L.P. Piston
Scale 30
M.E.P. 7·075
I.H.P. 3·43
Results of 4 hours Steam Consumption Tests.
Dia of HP Cylinder 5"
" " LP " 9"
Stroke 7"
Mean I.H.P. = 21·03
Average Total water consumption per hour = 434 · 5 lbs.
Water consumption per I.H.P. per hour = 20·65 lbs.
Air discharged - 13916 cu. ft. per min at 6½" W.G.
= 13·47 I.H.P.
Combined efficiency of Engine and Fan - 64 %

INDICATOR CARDS FROM CHANDLER'S FAN ENGINE.

The practical reversing propeller, that is, one with blades the pitch of which may be varied from a maximum in one direction to zero, and further to the same maximum in the opposite direction, so as to permit reversing the ship's motion without reversing the engine, is not yet. There are many reasons why its invention should be a profitable piece of work. The change of pitch, however, should be accomplished from the engine room or other control point; and preferably without stopping the engine.

There is yet considerable margin for improvement in ash-hoists on steamers. I know of one vessel (incidentally, one in the design of which I had a prominent part) in which the ash-hoist pump makes much more noise than the main engines—and these last are "twin triples." For passenger steamers this is offensive, especially at night—and yet there is never any room for much accumulation of ashes in the stoke-room; and if there was, the presence of the hot masses is not conducive to comfort of the stokers—and these need every bit of amelioration of their condition that human ingenuity, backed up by human kindness, can devise.

A good blower is needed, that will not consume too much steam. This appears, on its surface, a small item—and so it might be, if coal consumption were the only thing to be regarded, and if every steamer made only short trips in salt water, or plied exclusively in fresh. But there are vessels in which the water consumption up the chimney, due to a liberal use of the steam blower, is a much more important factor than

the extra coal consumption, and the blower actually costs more than it comes to.

The duty of the marine condenser is not half, and perhaps not one-fourth, what it should be. That is, the average condenser is much too big, and consumes by far too much cooling water. I know of but two kinds which have any claims to a scientific principle of heat exchange between the exhaust steam and the condensing water—and one of these is constructively bad.

There is also an opportunity for some one to get up something better than corset laces for packing the ends of condenser tubes. Brass ferrules, wooden ferrules, paper ferrules, all sorts of contraptions, have been proposed and used, and still the average engineer sticks to and swears by the corset lace, if he has ever tried it. And I don't blame him, for it is a good thing —in default of a better. Who will nominate its successor? (The inventor must, however, remember that in mechanics, as in politics, a nomination is not always equivalent to an election!)

Anyone who has ever had the deck of a yacht pulled up by steel rigging will agree with me when I suggest that if some benefactor will produce a steel wire rope that has a little "give" to it, such as one always gets in hemp, many ship-owners and others who "follow the sea" or have it "followed" for them, will rise up and call him blessed. The old fashioned "chains" and "channels" are rapidly disappearing, and eye-bolts are taking their places; but it is too much to expect six feet in length of hemp at the lower end of a hundred feet of steel wire will give as much elasticity as though the entire length had "give."

The thrust-block on board screw ships probably gives more trouble than any other member of the machinery, cranks included. It has a great deal expected of it. It must stand endwise pressure of the shaft, caused by the thrust of the screw, and this sometimes comes in one direction, and (particularly in the case of double and triple screws, where one screw is reversed in turning) sometimes in the other; although not often enough in the backing motion to permit the lubricant to get in. In this respect the crank-pin, which gets its pressure first on one side and then on the other, in each revolution, has the advantage of the thrust-block. Then the thrust-block has a very heavy weight resting on it, which pillow-blocks and out-board bearings (when these last exist, which is not always the case) do not entirely or even largely relieve, and as the ship rises and falls, the speed changes suddenly from the normal to two or three times that speed, a condition which is much more favorable to cutting than either very fast or very slow all the time would be.

And this mention of "racing" brings me to the marine governor. Any one who has made a trip on an ocean steamer — particularly on one of the "greyhounds" that cut their way through the water and always have wet decks—knows that the "gurring" of the screw is about the most disagreeable feature of the voyage. It aggravates seasickness, and never gives a let-up, day or night, if the sea be in the least bit rough —that is, if it be anything but "mill-pondy," which it very seldom is. The chattering makes every partition vibrate. This makes traveling less pleasant and lessens the number of transoceanic passengers; but it has a still worse effect—it racks the engines themselves, particularly the shaft and the cranks, and it gradually destroys the whole structure (which, after all, is only riveted together) by working the contacting surfaces against each other and making the rivets fit less and less tightly. Thus the evil increases from year to year, and the danger with it. Take a boat of 8,000 tons, and a length of only about nine times the beam, and put 5,000 horse power in it, and this "gurring" is not so noticeable, and the ship will last comparatively long. But take a hull of 10,000 to 12,000 tons, and a length of twelve times the "beam" or breadth, and then put 20,000 to even 25,000 horse power on board, in order to reduce the trip from 12 or 13 days, with the broad-beamed hull, to seven or even six, with the narrow one, and the difference becomes noticeable. We have a hull that is more readily vibratable by reason of being actually and proportionately longer; we increase the resistance that one meets by increasing (1) the number of vertical and horizontal strains that the waves give it, (2) the amount of endwise resistance that it gets, by increasing the speed at which it is driven into the masses of water, and (3) the amount of vertical hammering that it gets by reason of the rise and fall of the great pistons with their attached connecting-rods and cranks—and you can see how the life of a "racer," or, at least, her life as a racer, is much shorter than it would otherwise be if it were supplied with a good marine governor.

To get back to war vessels, of which, despite the proposition of his imperial and autocratic majesty, the Czar, we shall probably have to build a few dozens more, within the next ten years (just as honest burghers keep a loaded gun about, not for the purpose of shooting their immediate neighbors in day-time, but merely to discourage community of portable property, such as chickens and spoons). The ridiculous experience of finding that an eight-inch or a six-inch cannon, mounted in a separate turret ("duplex elliptic" or other) just on top of that containing a couple of thirteen-inchers, was put out of service when the use of the big fellows underneath commenced, should lead some one to invent a different relative arrangement for the small (?) and large calibers. And the fact that where two big guns stood side by side, if common black powder was used, the smoke from one gun prevented the next one's being sighted for a few minutes, particularly if there was no wind, and the vessel was not under way, points to the abandonment of black powder for modern warfare. As, however, the use of the present qualities of "smokeless" (?) powder has a choking effect on those in the vicinity, when the yellow vapors are encountered, and as the half-burned grains are unpleasant things to have driven into one's face, there seems to be a good opportunity for a chemist to produce a "Jonesite" or a "Smithite," or some other kind of an "ite," that will be a better neighbor. This "powder" (if sticks as big as a lead pencil or grains the size of a walnut may be so called) must have a high explosive effect, not be readily set off by concussion, must resist dampness tolerably well, and not alter its characteristics by age, must not corrode the gun nor foul it greatly; must not generate poisonous or highly noxious vapors when exploded; must be comparatively gradual in its burning, so as not to put too great a strain on the breech of the gun, before the shot has got started, and yet must have got completely converted to gas, before the shot has reached the muzzle —else there will be not merely a waste of powder, but unpleasantnesses for the gun's crew. It must be made from materials all of which are obtainable not merely in the country of manufacture, but in the neighborhood of the mill or factory; and these raw materials must be quickly convertible into the finished product. If the material can have a high specific gravity, so as to diminish the bulk to be carried, for a given weight and for a given explosive effect, so much the better.—Modern Machinery.

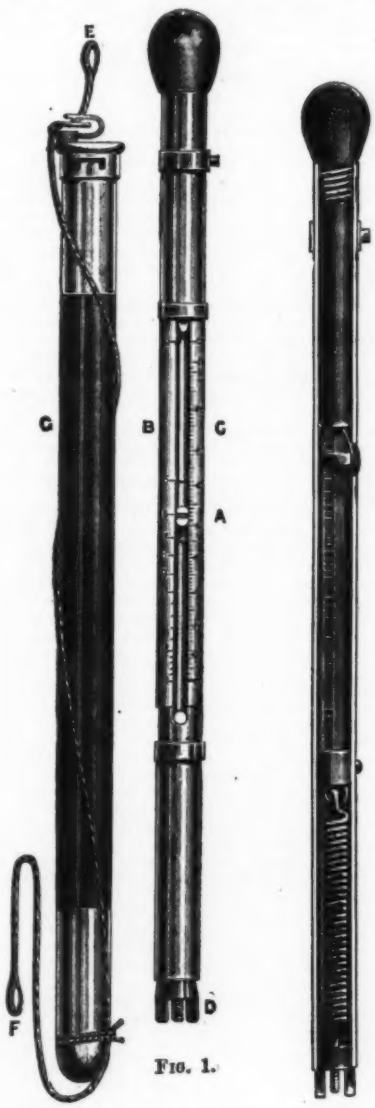


FIG. 1.

FIG. 3.

FIG. 2.

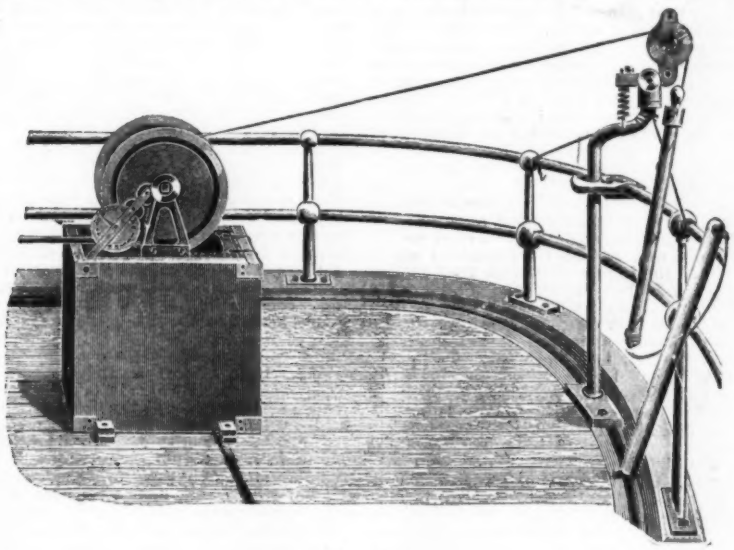


FIG. 4.

COOPER AND WIGZELL'S SOUNDING APPARATUS.

COOPER AND WIGZELL'S SOUNDING APPARATUS.

By CHARLES BRIGHT, F.R.S.E., A.M.Inst.C.E.

THIS device, the ingenious invention of Messrs. Cooper and Wigzell, consists of a winch, special wire, fairlead, sounder, and sinker. The sounder itself is most simple in construction. Actuated by hydrostatic pressure, the recorded depth is absolutely according to the pressure due to the vertical height of water over the sounder at the moment; it is not in any way affected by the speed of the ship, drift, length of line run out, variation of temperature, or height of the barometer.

The instrument is furnished with graduated scales of depths, the maximum being 100 fathoms. One of the two scales registers very shallow depths up to 20 fathoms only, and the other up to 100 fathoms. These scales are marked *B* and *C* respectively; and a change of scale from one to the other can be made by means of the thumb screws, *D*. A pointer indicator is provided for showing the maximum depth attained by a cast.

The sounder is composed as follows: At the bottom end (Fig. 2) is a German silver spring which is attached to a bar with teeth cut on its under side; at the end of this bar there is a piston which works inside a cylinder. On the bar itself we have a spring marker which fits into the teeth on the under side. When the marker is pressed down, it is released from these teeth, and is free to be moved to zero; this release is also effected automatically when the water pressure moves the piston up the cylinder during a cast. It will thus be seen that any number of casts can be taken without incurring expense, the only thing necessary being the return of the recording button or marker to zero.

This instrument fits into a protecting case (Fig. 3) furnished with a rope sling, one end of which is attached to the line or wire. To the other end of the latter is attached (Fig. 4) a sinker weighing about 28 lb., having a hollow in its bottom end for arming with tallow in the usual manner. It is necessary to draw the sounder out from its protecting case in order to read off the depth.

The writer has had the privilege of seeing a number of these instruments calibrated. In performing this operation each of them is marked off separately under water pressure from a hydraulic pump furnished with suitable test gages.

The patent wire used is of an excellent type. It is constructed of fine galvanized steel wires, braided with hemp steeped in solution, and is especially devised to avoid kinking or tangling. Being of ample strength for its work, there is no fear of losing the instrument.

The winch employed is made in two patterns. One is a simple cast iron arrangement suitable for cargo vessels. The other (Fig. 4) is of more expensive construction. In the latter case the winch fits into a teak-wood box, so that when not in use the barrel of the winch can be lowered into the box, the lid put on, and the whole made compact. The last pattern is also fitted with a frictional line measurer or counter for recording approximately the length of wire which has been run out. Both kinds are fitted with good brakes, enabling the users to keep the line well under control when it is running out.

This apparatus has been very largely adopted by the leading steamship companies, as well as by the various navies, and is most highly spoken of, both in regard to its utility and reliability. There are about a thousand in use. We are indebted to London Engineering for the engravings and description.

PROGRESS IN THE IRON AND STEEL INDUSTRIES.*

THE announcement that Her Majesty the Queen will be graciously pleased to accept the Bessemer medal for 1899, in commemoration of the progress made in the iron and steel industries during her reign, will be received with enthusiasm throughout the empire. What the progress has been it will be my privilege to indicate in this address; for your last president of the century, in bidding it a respectful farewell, must offer the best retrospective tribute he can to the grandest industry in the world's history.

This address will, therefore, be mainly devoted to the consideration of British efforts in connection with iron and steel. I shall hope on another occasion to pay homage to the services rendered in other countries to our branch of metallurgy, but in view of our autumn meeting last year at Stockholm, I cannot proceed further without making a brief reference to

* Abstract of the presidential address to the Iron and Steel Institute, by Prof. Sir W. Roberts-Austen, K.C.B., D.C.L., F.R.S., delivered before the members of the Institute on May 4.—From Nature.

Sweden. To her scientific men our debt is great and of long standing, for we have profited by their labors from the eighteenth century until now. We appreciated the interest in our proceedings which was shown by the presence of His Majesty the King and the royal princes at our meetings in the Riddarhus. The gracious kindness of His Majesty during the magnificent reception at his palace of Drottningholm will never be forgotten by those of us who were present. The spontaneous warmth of our reception by the Swedish people also touched us deeply, and the memories of our visit will be handed down as traditions to future members of our Institute, who, in the days to come, will, we trust, again seek the aid of Sweden by supplementing the ores of our own possessions with those from within the Arctic circle.

From the technical point of view, as the eighteenth century closed, a new era in the metallurgy of iron had already begun. Abraham Darby had successfully introduced the use of coke in the blast furnace; James Watt had, by his powerful engines, much facilitated the production of blast and had greatly stimulated the out-turn of pig iron. Nevertheless, the total annual production of pig iron in the year 1799 did not exceed some 150,000 tons. From the scientific point of view the situation was one of singular interest. The early writers held that good and bad qualities might be inherent in the iron itself. Pliny points out how greatly the properties of iron depend upon its treatment, but he thought that as for the kinds of iron, they were many and all were distinct, and the first difference arises from the diversity of the soil and climate where the mines are found. But Pliny's view survived far into the present century, and evidence of it lingered in the effective and graceful speech in which the member for Merthyr proposed a vote of thanks to our first president on the delivery of his inaugural address. Mr. Fothergill said then that "thirty years ago the idea prevailed universally . . . that good iron was to be found in certain localities, and could be procured from no other place; it was found good in one place and bad in another." He adds: "Enlightened progress of the last thirty years has shown that the quality of iron depends upon the alloy with which it is mixed."

Enduring as the old view as to the influence of locality was, an experimental basis for a more accurate one had been established very shortly before the present century began, and some, at least, knew that the properties of iron depended on the presence or absence of certain other elements. This position was clearly established by the great Swedish chemist, Bergman, of Upsala, who had shown that carbon is the element to which steel and cast iron owe their distinctive properties. He had initiated the employment of calorimetric methods in determining the properties of iron and steel. He insisted that the real difficulty is to explain how it is that the presence of 0 5 per cent. of carbon in iron enables the metal to be hardened by quenching from a red heat, or, in his own expressive words, Ceterum quomodo dimidia centesima, plumbaginem efficiens, tantam provocare possit differentiam, nodus est gordius haud facile solvendus. Bergman, moreover, anticipated the later phases of modern research by claiming that iron is a polymorphic element, and plays the part of many metals. In this early view as to the allotropy of iron it should be remembered that in 1790 our countryman, James Keir, followed him closely by urging, before the Royal Society, that what we now call passive iron "is really a distinct form of iron, the alteration being produced without the least diminution of its metallic splendor or change of color."

Clouet's celebrated experiment on the carburization of iron by the diamond followed. Doubts, however, were not finally set at rest until 1815, when Pepys, a working cutler in London, excluded the possibility of the intervention of furnace gas. But, as soon as the present century had well turned, the industrial world was in possession of the fundamental fact that carbon is the element of dominant importance in relation to the metallurgy of iron. Well might Bergman express astonishment at the action of carbon on iron. Startling as the statement may seem, the destinies of England throughout the century, and especially during the latter half of it, have been mainly influenced by the use of steel. Her steel rails seldom contain more than Bergman's half per cent. of carbon. Her shipplates, on which her strength as a maritime power depends, contain less than half that amount. It is essential that the significance of this fact should be clearly understood. Our national existence has long depended on iron and steel. They have been the source of our wealth, one of the main elements of our strength, one cause of our maritime supremacy. Hardly a step of our progress or an incident of our civilization has not, in one way or another, been influenced by the properties of iron or steel. It is remarkable that these properties have been determined by the relations subsisting between a mass of iron, itself protean in its nature, and the few tenths per cent. of carbon it contains. These properties are, it is true, modified either by the simultaneous presence of elements other than carbon, or by the thermal or mechanical treatment of the mass. The growth of our knowledge of the facts constitutes a large section of our scientific and industrial history. The question arises, Was our national progress delayed by the unreadiness of the technical world in England to take advantage of the facts that science had established?

If we consider the position from the point of view of two remarkable men who were looking for the dawn of the nineteenth century as we are for that of the twentieth, we shall, I think, be satisfied that our progress received no check from failure of industrial workers to assimilate the teaching of science. These men were Black and Cort. Of the scientific men then living, the greatest chemist was Black, professor at the University of Edinburgh, whom Lavoisier had generously acknowledged as his master. Black fully recognized the importance of Bergman's work, and on his own part insisted on the importance of what would now be called the change in molecular energy as the physical basis on which the properties of iron and steel depend. Black, moreover, in his public lectures gave a singularly accurate description of the process of decarburizing iron called "puddling," and devised by "a Mr. Cort," with the results of whose work Black was soon to become familiar. Considering how recent the knowledge of the meaning of oxidation really was at the time, Black's statements with regard to the theory of puddling are truly remarkable. Later on he furnished the government with an elaborate report on the quality of the material obtained by puddling. He showed, by such mechanical tests as the experience of the time suggested, the superiority of puddled iron, and pointed out that it was more suitable than foreign iron for the appliances "on which," as he says, "the lives of our seamen and the safety of our ships have hitherto mainly depended."

At the end of the century we are justly proud of our colonial possessions, and are satisfied that the varied applications of iron and steel will enable us to knit together all parts of the empire. At the beginning of the century, Lord Sheffield, in his "Observations on the Commerce of the American States," writing in the early days of Cort's process, shows that it would help to make British iron as cheap as the foreign, an event which he considered would be more advantageous to England than the possession of her American colonies. Black died in 1799, Cort survived till 1800, so that as the eighteenth century closed, the most eminent scientific man and the foremost practical metallurgist of the generation stood side by side. To Cort we owe the greatest technical advance the modern world had seen; to Black the recognition of the importance of molecular energy in relation to metallurgical problems.

The production of pig iron in this country also received a great stimulus from the discovery by Mushet, about the year 1800, that the large deposits of blackband ironstone could be utilized. The century opened with, in round numbers, an annual production of pig iron not exceeding 200,000 tons, of which less than one-third was converted into bars and other descriptions of wrought iron. The capital invested was under five millions, and employment was furnished for nearly 200,000 people.

Returning to the scientific aspect disclosed at the dawn of the century, the year 1803 was an eventful one for science. Nevertheless, the impulse given to research was not in the most favorable direction for the advancement of metallurgic art. The influence of a small proportion of carbon on iron had been recognized, but the quantitative relation between the iron and the carbon was only considered as bearing on the nature of the product and not at all from the point of view of chemical union. When, therefore, in 1803, Claude Louis Berthollet published his "Essai de Statique Chimique," it appeared that the action, of what for the moment I may be permitted to classify as the action of traces upon masses, was in a fair way to be elucidated for the following reason. Berthollet pointed out that "in comparing the action of bodies on each other which depends on their affinities and mutual proportions, the influence of mass has to be considered." Unfortunately, in succeeding years the views of Prout, the courteous opponent of Berthollet, prevailed, mainly through the powerful aid of Dalton, who published also in 1803 his first table of atomic weights. Hence the phenomena which could not be attributed to fixed atomic proportions were set aside and usually neglected. Evidently the action of one-tenth per cent. of carbon on iron could not be explained by the aid of combining weights. The century was more than half over before a school of eminent chemists arose, who did not insist that matter is minutely granular, but in all cases of change of state made calculations on the basis of work done, viewing internal energy as a quantity which should reappear when the system returns to its initial state.

The production of cast iron and bar iron was rapidly increasing, and the suitability of cast iron and bar iron for the construction of bridges became evident to engineers, among whom Telford was pre-eminent. A distinguished professor, a worker in pure science, came, in the person of Dr. Thomas Young, to the aid of the technical worker. The need of studying the mechanical properties of iron and steel was evident, and Young showed that the work done in permanently extending or in compressing iron or steel could be represented by a coefficient, to which he gave the name of the "Modulus of Elasticity." This coefficient has probably rendered more service in the development of the study of the strength of iron and steel than any other which has been determined. It is of great importance, because upon it depends the deflection which a structure will take under strain. Young, evidently with a view to bring home evidence as to the great rigidity of steel, gives in his original paper a quaint illustration. He therein shows that if "Hook's law holds," a hanging rod of steel would have to be 1,500 miles long in order that the upper portions of it might be stretched to twice their original length. I would incidentally point out that on the basis of Young's calculations, such a column 1,500 miles high, if it were 1 foot $2\frac{4}{10}$ inches in diameter, would represent the output for the past year of Bessemer steel in this country alone. Statements of this kind had such a singular fascination for Sir Henry, that I have permitted myself a brief departure from chronological order in offering this one.

[The president then referred to the patent granted in 1817 to the Rev. Robert Sterling for the "regenerative furnace," and to the work of S. B. Rogers, who introduced "iron bottoms" in the puddling furnace. An interesting fact was mentioned which justified the claim made in the address, that Rogers was the pioneer of the great process afterward known as the "basic" process of dephosphorization. Faraday's work on alloys in 1820, and his discovery of "a carburet of iron" in 1822, was then described, and the merits of Neilson's discovery of the "hot blast" in 1828 were fully dealt with. After a brief reference to the work of Thomas Andrews, of Belfast, on the "heat of combination," the president proceeded to review the theories of the action of the blast furnace, and especially referred to the work done in the year 1846.]

It was pointed out in 1846 that in the blast furnace there was evidently a kind of tidal ebb and flow in the relations of carbon and of oxygen, resulting sometimes in reduction, and at others in oxidation or carburization; but the changes were all capable of more or less simple expression if viewed either from the atomic or the dynamic standpoint. As the furnaces grew in dimensions, their flaming tops threw a lurid glare over the country, and, "like the dying sunset kindled through a cleft," revealed the magnitude of the problems involved in blast furnace practice, which were seen to be disproportionate to their apparent simplicity.

In the first half of the century efforts were directed mainly to obtaining a material—cast iron containing some $3\frac{1}{2}$ per cent. of carbon, and fusible at a temperature readily attained in the blast furnace. In the second half of the century, while efforts to obtain this fusible material were increased, attention was also directed to removing the carbon, and obtaining a product which had a melting point of 400° C. (720° F.) higher than cast iron. This product was either cast directly into ingot molds or recarburized to the extent necessary to constitute the various gradations of steel. Sheffield hardly knew steel except as a material to be used for the manufacture of cutlery, for which she had been famous since the time of Chaucer.

It is characteristic of our British methods that special circumstances and needs, mainly arising in connection with the development of the steam engine and railways, revealed the broad principles by which the production of iron must be governed. It was natural, therefore, as time went on, that in the work of successive inventors the guidance of scientific principles became progressively evident as ill-directed efforts were gradually replaced by the results of systematic experiments.

The second half of the century began with events of strange importance. The great exhibition revealed our industrial strength to all nations. The official reporter of the metallurgical group states that 2,250,000 tons of pig iron were annually produced in this country, and its estimated value was £5,400,000. The annual production had risen in fifty years from two hundred thousand tons to over two and a quarter millions. Sheffield produced at the opening of the century 35,000 tons of steel, of which 18,000 tons were cast steel. Messrs. Turton exhibited a single ingot of steel weighing 2,688 pounds, but Krupp showed an ingot of double the weight, for our country was only preparing for the great change which was so soon to enable it to lead the steel manufacture of the world.

A noteworthy feature of the exhibition was the collection of iron ores of this country, exhibited by Mr. Blackwell, who subsequently, and most generously, provided funds for their analysis. With reference to this collection, the reporter points out that in this country "the ores are not carried far, except where there is great facility for transport." This is noteworthy, as before the century was much older an important supply of ore was brought from Spain, and in the near future we may even seek a supply for British furnaces from distant parts of our own empire.

The year 1851 was, moreover, an important one for metallurgy in this country, as it saw, by the wisdom of H. R. H. the Prince Consort, the establishment of the institution which developed into the Royal School of Mines. If the projected scheme of instruction had been fully carried out, the establishment of a general system of technical instruction, which the pressure of necessity is slowly forcing upon us, would have been anticipated by forty years.

The year 1856 will be ever memorable in the metallurgical annals of our nation as that in which Bessemer gave the description of his process to the world at the Cheltenham meeting of the British Association. As regards the process itself, we have too lately lost our great countryman, and many of us are too familiar with the details of his labor to be able either to fully estimate its value or to realize the wonder of its results. Let us try to think of the Bessemer process as I believe those at the end of the twentieth century will, whose views range over a wider perspective than we can command. The economic aspect of the question will naturally strike the metallurgists of the twentieth century. They will see that in 1855 the make of steel in Great Britain did not exceed 50,000 tons, and the cost of the steel produced sometimes reached £75 a ton. They will see that thirty years after the publication of Bessemer's paper the production of Bessemer steel rose to 1,570,000 tons, and that ship plates were sold at £6 10s. a ton. It will be noted that before the century closed, the maximum production of Bessemer steel in this country in one year reached 2,140,000 tons. The scientific aspect of the process will, however, excite their widespread interest, for, before the end of the twentieth century, metallurgy will be taught in our older universities. It will be seen that, notwithstanding the title of Bessemer's Cheltenham paper, he recognized and insisted on the fact that the intense heat was engendered by the combustion of the elements within the fluid bath. It will be noted in what close relation the purely scientific work of Thomas Andrews, of Belfast, on the heat of combination, stands to that of Bessemer, and that another instance is presented of the dependence of industrial work on pure investigation. Bessemer's proposal to employ a mixture of steam and air will not be ridiculed as it has been, for speculation will be rife as to whether he did not hope that the liberated hydrogen might remove sulphur and phosphorus, notwithstanding the feebly exothermic result of the ensuing combination, and in spite of the cooling effect of water vapor. In view of the fact that endothermic combinations take place at a high temperature, the possible action of hydrogen as a decarburizer will be dwelt upon. Prof. Noel Hartley's papers upon the thermo-chemistry of the Bessemer process will be read with much interest. Surprise will, however, be widely felt that physicists generally of the last half of the nineteenth century did not see in the lovely flames of lilac, amethyst, gold, and russet, or in the "stars suspended in a flying sphere of turbulent light" which come from the converter, an appeal to fully investigate their cause and to study the dynamic problems presented by the intense heat engendered. Why was not the destination ascertained of the 1,000 cubic feet of argon which accompanies the air passing through the metal during an ordinary Bessemer 10-ton blow? Why were not more strenuous efforts made to ascertain the effect of the temperature of the bath on the nature of the metal?

It will be felt that, as the eighteenth century had closed with a clear statement as to the true nature of oxidation, the nineteenth century had seen its magnificent application in the Bessemer process.

As regards the work of Mushet, future generations will, I believe, desire to add nothing to the words of the president of this institution, who, in 1875, had the pleasure of awarding the Bessemer medal to him. Mr.

Menelaus then said that "the application of spiegeleisen . . . was one of the most elegant as it certainly was one of the most useful inventions ever made in the whole history of metallurgy."

(To be continued.)

GEODETIC OPERATIONS IN THE UNITED STATES.*

THE geodetic operations in the United States, as executed by the Coast and Geodetic Survey, may be grouped into three distinct periods of time. The work was authorized by Congress in 1807, but a quarter of a century elapsed before anything was done in the field worthy of the name of geodesy. This closed the first period, which may be characterized as the era of preparation and education of public sentiment. In 1832 operations were begun with vigor, and the foundation was laid for a great national work. The survey was conducted on the same general lines of policy for eleven years, when the reorganization of 1843 established its permanent status. No great deviation has since been made from this plan, which has now held for fifty-five years. If we eliminate the civil war period of five years, during which work was suspended, and regard operations before the reorganization as of a preliminary nature, we have half a century of geodesy. During its comparatively short existence the survey has been three times under the control of the Treasury Department, twice under the navy, and once under the law requiring its personnel to be army or navy officers. The direction of the work has, however, remained throughout in the hands of a civilian, and civilian methods have been applied in the administration. At the present time it has been continuously under the Treasury for a period of sixty-two years. Although statistics do not always give an adequate conception of the work to which they are supposed to bear testimony, a general idea of the activity displayed may be had from the following statement of work done:

350,000 square miles (906,500 sq. kilo.) of triangulation, embracing
15,000 stations for horizontal measures, and determining
28,500 geographical positions at which
1,000 astronomical coördinates have been observed.
38,500 square miles (99,710 sq. kilo.) of topography, embracing
11,600 miles (18,670 kilometers) of general coast line and more than
100,000 miles (160,900 kilometers) of shore line (rivers, etc.), also including
51,000 miles (82,080 kilometers) of roadways.
545,000 miles (877,100 kilometers) of sounding, covering
164,000 square miles (424,800 sq. kilo.) of area, besides
93,000 miles (149,700 kilometers) of deep sea sounding, in which
14,000 bottom specimens were obtained.
4,600 original topographic and hydrographic sheets, from which
1,300,000 charts have been made and distributed:
30,000 original volumes of observations, including magnetic records from
1,100 stations.

BASE LINES.

Two hundred and three base lines have been measured, of which nineteen, on account of their accuracy, length, and geodetic connection, are classed as primary. The average length of these is 9,892 meters. The probable error, which includes both that of measurement and the comparison with the standard, is 22·2 millimeters, or about 1/445,000 of the length stated. Speaking of the three types of apparatus used in the survey, and referring now to errors of measurement purely, it may be said that with the different forms of metallic bars, compensating and otherwise, the error is one millionth part of the length measured. With the tape line the accuracy may be increased to 1/2,000,000, while with a rod in melting ice 1/5,000,000 is easily attainable. In the first form the contacts are material; in the last, optical; with the tape they are linear. The cost is greatest for the rod in melting ice, and least with metallic bars.

Attention may here be called to a new form of base apparatus named the Duplex and designed by Assistant William Eimbeck. It consists of two bars, brass and steel, five meters in length, so arranged that the measure may be made with each component separately and simultaneously. It may also be employed as a Borda scale, or the temperature may be directly observed. Some unique features, which need not here be described, are employed in its manipulation. The Salt Lake base, measured in 1896, gave results with either component having a probable error of less than 1/5,000,000 part of the measured length.

TRIANGULATION AND ARCS.

The shore line of the United States, exclusive of Alaska, is 5,452 miles (8,774 kilometers). This has been covered by triangulation, with the exception of a few hundred miles on the northwest coast. An oblique arc of 32° has been measured from the northeast boundary in Maine to the southwest limit of Alabama, on the Gulf of Mexico, and an arc of 49° on the 39th parallel of latitude has been completed, from the Atlantic to the Pacific. All of the New England States, a large part of the Middle ones, and considerable areas in the South and West have been covered with triangulation. Adjacent regions have had careful reconnaissance. The work in this direction has been executed on a large and accurate scale. The greatest triangle has sides of 133, 167, and 190 miles (214, 269, and 306 kilometers). The highest station is over 14,000 feet (4,267 meters). Operations of such magnitude justify the introduction of refinements not usually employed. The latitudes are corrected for elevation, and the horizontal directions are changed, to reduce them to the sea level of the observed station. A distinctive feature in the final adjustment is the application of weights depending on both the station errors and those arising from the closing of figures. These are treated separately, but the final weights consist of two parts, one resulting from local conditions and varying with each direction, and the other deduced from the formation of triangles and remaining constant for the network under consideration. In the California work the probable error of a direction at any station was 0".081, while that from the closing of triangles was about twice as much. The latter necessarily includes the former. The two are separated by means of the formula

$$e_c = \sqrt{e_t^2 - e_s^2}$$

which gives the resulting combination error as ± 0".169. e_t is the probable error of a direction from the closing of triangles, and e_s is the average probable error of an observed direction from station adjustment. Each direction, therefore, enters the final adjustment with a weight derived from measures at its own station, added to the above value, which represents the constant part for the entire figure. The cost of the transcontinental arc from Cape May to San Francisco was $200 per linear mile ($124 per kilometer), three and a half dollars per square mile ($1.35 per sq. kilo.), and $2,000 per station.

A fine example of rapid expansion from the base to a fully developed net of triangulation is found in the vicinity of Salt Lake, and is a characteristic specimen of primary work as carried out in the Rocky Mountain region of the United States. The average height of the thirteen stations composing the main scheme is 11,356 feet (3,431 meters), while the average length of the lines connecting them is 159,734 kilometers (99¼ miles). The distance between Mount Ellen and Uncompagre is 294,104 kilometers (182¾ miles). This remains to the present day the longest line observed from both ends and forming an integral part of a regular system of triangulation executed by any trigonometric survey in existence. Indeed, the entire chain from the Sierra Nevada on the west to the Mississippi plateau on the east is without a parallel in similar work, when we consider the magnitude of the geometrical figures, the elevation of the stations and the refinement of the individual measures.

Referring to a part of this work—the base net at Salt Lake, Utah—the following details are of interest:

The elevation of the base above sea level is about 4,224 feet, while the mean height of the stations composing the quadrilateral is 11,088 feet. In only five steps we pass from a base 11·2 kilometers in length to a line 237,765 kilometers long (Pilot Peak, Mount Nebo). This involves an average multiplication of 4¼ times for each step of expansion, which is within the limit set for development in well conditioned triangulation. The resulting quadrilateral in which the base line expansion culminates and on which the transcontinental extension rests contains nearly 10,500 square miles and is the largest yet realized. The base net including this figure (Ogden, Mount Nebo, Ibepah, and Pilot) was adjusted separately and brought out the following criteria of accuracy:

FROM STATION ADJUSTMENT.

Average probable error of a single observation of a direction	= 0".71
Average probable error of an adjusted direction	= 0."10

FROM FIGURE ADJUSTMENT.

The largest correction is	0".84
And 55 per cent. of the corrections are less than	0".25

The probable error of the side Ibepah-Nebo, depending on angular measures only, is 1/280,000 of its length.

Heliotropes were continually employed, and the angles were measured with a theodolite having a horizontal circle of 20" diameter and a magnifying power of 83.

ASTRONOMICAL WORK.

Aside from the work in practical astronomy incident and necessary to the operations of every trigonometrical survey, attention has been given to various other phases of the subject. It has not alone sufficed to point out and demonstrate the utility of the method of equal zenith distances for latitude, and of the application of the telegraph to longitudes. The Coast and Geodetic Survey feeling the necessity of better star places, arising from the use of the methods just mentioned, has devoted some of its energy to the perfection of star catalogues. It is probably no exaggeration to say that the declinations given in our field lists are the best attainable anywhere. More than fifty of the best modern catalogues are corrected for their systematic errors, and each is given weight depending on the value of the work and number of observations. A collection of all these data, and their consolidation into one homogeneous result, eliminates as far as possible all known sources of inaccuracy, and gives us finally the most reliable positions. A list so constructed of several thousand stars has been already published, many of which are especially adapted to southern work. The average probable error of a declination may be given as rather less than ¼ of a second; a degree of precision which enables an observer to determine his latitude from 20 pairs, in one evening, with an uncertainty of only ± 10 feet. This is sufficient for the purposes of geodesy. Incidental to regular astronomic work, the survey has equipped and sent out no less than 35 parties for the observation of solar eclipses and transits of the inferior planets, which work has required the occupation of stations in every continent and Polynesia. The variations of latitude have been determined at three stations, each one having been occupied more than a year.

MISCELLANEOUS OPERATIONS.

The legitimate field of investigation in a geodetic service embraces many subjects outside of those already specified. In the execution of the task before us a free interpretation has been given to the law authorizing the work, and the kindred subjects of hypsometry, magnetism, gravity, and physical hydrography have been pursued along with others more strictly within our province.

Five thousand miles (8,047 kilometers) of precise leveling have been executed, including four independent determinations of the height of St. Louis. Two have been made from the Atlantic at Sandy Hook, and two from the Gulf of Mexico at Biloxi.

A comparison indicates that the surface of the Gulf is somewhat higher than the sea level at New York, and this has been verified in character, although not precisely in amount, by a line across the peninsula of Florida, three times repeated. Other subsidiary lines have been observed. The limit of error has been that usually adopted in similar work, viz., 5 mm. $\sqrt{K}$. The heights by spirit level have been supplemented and controlled by micrometric measurements of zenith distances. In the determination of elevations necessary to reduce the base lines along the transcontinental arc to sea level the latter method has been employed across the Allegheny and Rocky Mountains. The spirit levels are continuous from Sandy Hook to Denver and Colorado Springs. They are checked by zenith distances from the Chesapeake Bay to the Ohio River, and supplemented by the same method from Denver to the Pacific coast, where the spirit levels are not yet completed.

Permanent magnetic observations have been in operation at Philadelphia, Key West, Madison, Los Angeles, and each one has furnished records for five consecutive years; with one exception a self-registering apparatus has been continuously and exclusively employed in each locality. These data added to records from 1,100 widely distant points, many of which are secular variation stations, furnish precious material for the study of the earth's magnetism. The work of the survey in the investigation of the force of gravity has been carried on both within and without the limits of the United States. Twenty-eight foreign stations have been occupied, including points in Europe, Asia, Africa, Australia, and many islands in both the Atlantic and Pacific. New light on the subject of volcanic formation, as well as on the constitution of the earth's crust, has come from this work. Fifty-nine stations have been observed at home, including a line across the continent. Half-second pendulums are now exclusively employed, and the determinations are purely differential. The period of oscillation is usually known to within a few millionths of a second.

In the field of physical hydrography most comprehensive studies have been made.

The exploration of the Gulf Stream, including a study of its density, temperature and currents, the geology of the sea bottom, the establishment of cotidal lines, the determination of the ocean depth from earthquake waves and other specialties in the domain of hydrography, have been made a part of the regular work. The hydrography of the coast, to the head of tidewater, has been developed side by side with the triangulation and topography.

The practical results of the survey are shown in the publication of the annual reports, the issue of charts, notice to mariners (corrected monthly), coast pilots for Atlantic, Pacific, and Alaskan waters, tide tables (now extended to foreign ports) and various miscellaneous publications in special lines of research.

PRESENT AND FUTURE OPERATIONS.

A resurvey of Chesapeake Bay, the measurement of an arc through the United States on the 98th meridian, and the development of Alaskan geography, are among the projects of Dr. Pritchett, the present superintendent of the organization. All these have been carried on during the last two years. The line of transcontinental precise levels is being pushed westward with all available means. Primary triangulation on the Pacific coast been resumed, and will soon be completed from San Francisco to the Mexican boundary. Hydrographic surveys are in progress along the Atlantic seaboard, on the Pacific, and at the mouth of the Yukon in Alaska. Numerous topographic, astronomic, and magnetic parties are employed in the interior.

An extension of the great arcs of the United States into Mexico and the British possessions has been proposed by Dr. Pritchett, and diplomatic representations between the interested governments looking toward concerted action in the near future have already been made. This will give to North America an additional meridian arc of about 55° and an oblique one of 33°. Together with existing arcs, the proposed material will practically exhaust our contribution to the determination of the earth's figure.

In the ordinary prosecution of the field work since 1895 about fifty parties have been employed during the course of each year. Added to this, the purely hydrographic work has been carried on by a fleet of sixteen vessels, of which ten are steamers. The operations have been widely distributed, extending as far as the Pribilof Islands in the Bering Sea. A longitudinal determination was made from Sitka, of Kadiak and Unalaska, in which twenty-one chronometers were carried on four successive trips. The probable error of the resulting longitudes was 0".20 for the former and 0".21 for the latter. A tidal indicator, similar to the one in New York, has been erected at Philadelphia, and one is in process of construction at San Francisco. The mechanism, actuated by the tide, furnishes the navigator at any moment, at a distance of one mile, with necessary information as to the character and amount of the tide.

Among the auxiliary duties of the service may be mentioned the establishment of trial speed courses for ships of the navy (a number of which have been recently laid out); the exploration of oyster beds; the fauna of the Gulf Stream; the administration of an office of standard weights and measures, from which prototypes are issued to the different States; meteorological researches for the use of the coast pilot; the study of astronomical refraction; mathematical investigations on the theory of projections, on the equations of steady motion, on errors of observations; and finally, in experimental researches in engraving, electrotyping, and lithography; all of which knowledge finds application in the various fields of activity now covered by the Coast and Geodetic Survey.

WORK OF THE UNITED STATES ENGINEERS.

Geodetic surveys have also been carried on by the corps of engineers of the United States army. That of the Great Lakes was completed in 1882. The work was reorganized in 1892, and resurveys and extensions thereto are now in progress. Changes in the original plan have been introduced, chiefly in the direction of rapidity of execution. Fewer positions on the circle are now used for horizontal angles, and adjustment is effected by separate small figures, rather than through any extended scheme. In the measure of the Mackinaw base three tapes were used, each a kilometer in length. Each section of the tape was compared with a

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CLIMBING DETACHMENT OF DR. MEYER'S EXPLORING PARTY.

standard length of 100 meters established on the ground. This standard length was determined by means of an 8-meter bar packed in ice, which in turn was compared with the Repsold meter, R 1878.

The engineer corps of the army has also had charge of the Mexican boundary survey, and of the work done by the Missouri and Mississippi River commissions. The report on the Mexican boundary is already in type, but is not ready for distribution.

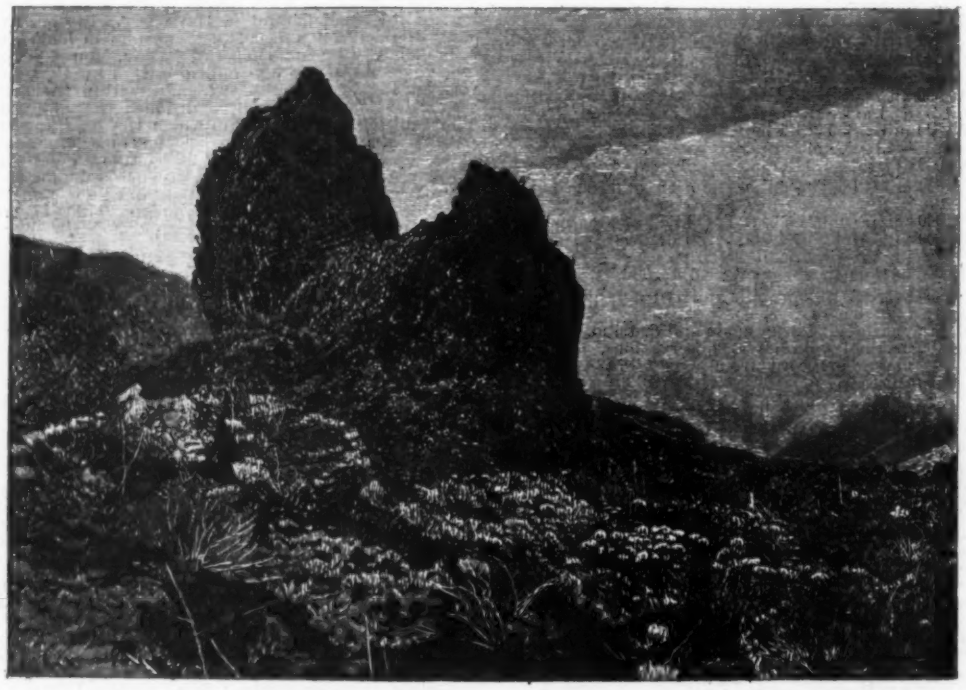
The Missouri River commission has completed a triangulation from St. Louis to Three Forks, in Montana, a distance of 2,551 miles. The work follows the river and covers the valley from bluff to bluff. Precise levels have been run over 807 miles of it, and ordinary levels cover the remainder. Ten base lines have been measured with a standardized steel tape.

The Mississippi River Commission, utilizing some work already done by the Lake Survey, and the Coast and Geodetic Survey, has now a complete connection from the Gulf of Mexico to St. Paul, in Minnesota. The total distance is about 1,600 miles. Twenty-seven bases have been used, of which eighteen have been measured by the commission with a steel tape 300 feet long. The work has been adjusted by quadrilaterals employing the method of least squares.

E. D. PRESTON,
Executive Officer to Superintendent United States Coast and Geodetic Survey.

DR. HANS MEYER'S LATEST KILIMANJARO EXPEDITION.

Semper aliquid novi ex Africa. The old saying still holds true, although one would believe, from the geographies, that there was scarcely anything new to discover. The large white patches which the map once contained are rapidly being reduced to small spots, through the restless activity of travelers and explorers; while many rivers and lakes, heretofore represented by lines and dots, have been given definite shape. The map has become filled with the names of new mountain chains, and of new lands and peoples.



ERODED ROCK ON THE WEST SLOPE OF MOUNT KILIMANJARO.

MEMBERS OF THE EXPLORATION PARTY CAMPING OUT IN A CAVE 12,000 FEET ABOVE SEA LEVEL, IN THE LAVA STREAM ON THE WEST OF MOUNT KIBO.

DR. HANS MEYER'S LATEST KILIMANJARO EXPEDITION.

Nevertheless, these once unknown places have not, as yet, been exhausted of their interesting contents. A striking example of this is seen in the discoveries of the fourth East African expedition, under the well-known geographical explorer, Dr. Hans Meyer, of Leipzig, which has just returned. Dr. Meyer is a most experienced African traveler. Between 1886 and 1889, when but thirty years of age, he repeatedly journeyed through south and east Africa, and increased our knowledge of the English and German possessions. After climbing for the first time almost to the top of the gigantic volcano Kilimanjaro in 1887, and making a map of the country between Kilimanjaro and Mombassa, he traversed, in 1888, the whole length of the mountainous region of Usambara, the greater part of which had never been explored up to that time. He was taken prisoner by a band of insurgent Arabs under Buschiri, and kept in chains, until he had paid a high ransom. The next year, however, he fitted out a new expedition, and succeeded not only in ascending, for the first time, the highest mountain peak of Africa, Mount Kibo (19,718 feet), of the Kilimanjaro range, and finding at the top the first African glacier, as well as a colossal frozen crater, but also in making a map of this mountain height, and exploring it in every particular.

Since the publication of Dr. Meyer's work, "Ostafrikanische Gletscherfahrten" (East African Glacier Journeys), almost ten years have passed, and in the meantime much has been found out about the Kilimanjaro range by naturalists and officers of the German colonial army, but nobody besides Hans Meyer has pierced the high mountain region. Just there many problems still lay unsolved, which were full of significance, not only for the Kilimanjaro range, but as regards the nature of all high tropical peaks. The huge volcano, towering out of the tropical heat of the equator into the icy polar region of its summit, becomes as it were a model of all high mountains of the earth.

These problems started Hans Meyer toward East Africa for the fourth time in June of last year, after he had carefully organized a new expedition, and found a valuable companion in the Munich painter, Ernst Platz.

Willingly aided by the foreign consul, and by the imperial governor, General Siebert, Meyer was enabled to engage quickly in Tanga a small caravan of some thirty chosen Waniamwesi. Then he took the small and very primitive German railway to the foot of the Usambara Mountains and passed through the eastern mountain region, daily forming plans which encouraging impressions led him to believe would succeed. From there he traveled across the lower plains of the Pangani and Mtomasi to the southern Kilimanjaro. As a base of supplies for his wide operations, he chose the military station of Moschi. This place is the residence of John, the chief of the district, who is well acquainted with the country. Dr. Meyer speaks very highly in his report of the aid given him by Chief John in reaching his destination, and also of the work of the Kilimanjaro mission, whose new house had been built in the upper part of Moschi by the Leipzig Evangelical Mission.

With a small company selected from the members of his exploring party, Hans Meyer passed through the wooded zone into the region above. At first he worked on Mawensi, the eastern peak of the Kilimanjaro range, 17,580 feet high, and explored especially the eastern slope of a huge ravine, which forms a cleft in the mountains from top to bottom, a distance of about 13,120 feet. Then he traveled over the plains around the Kilimanjaro range from east to north, and started from the Massai colony of Leitokitok to ascend Mount Kibo on the unexplored north side. He passed through the wooded region (included between the 5,900 and 9,840 foot levels), the grassy belt lying above it (between the 9,840 and 13,120 foot lines), and still further upward through the high district beyond the limits of vegetation, where he succeeded in reaching the crater at the summit after a six days' climb. The last two days he was accompanied only by the painter Platz. At their highest rocky camp (14,596 feet

above sea level) the thermometer registered 8 degrees Centigrade during the night. They reached the highest point of the summit after great exertion, passing through the Hans Meyer notch (18,991 feet high) of the frozen upper edge of the crater, which the explorer had entered for the first time in 1889.

In the crater and on the sides of the peak, Dr. Meyer found that the ice line had fallen back considerably since 1889. He thinks the reason for this is to be found in the fact that the climate is continually becoming drier, a phenomenon noticeable in other parts of East Africa. If a new period of heavy moisture does not come soon, he believes that in ten years more very little ice will be left on the Kilimanjaro range. He was uncertain before whether Mount Kibo is an active volcano or not, but this time he found nothing which would cause him to believe it still active. He classes it, therefore, among extinct volcanoes.

After joining the main caravan again, Dr. Meyer continued his journey through the upper forest region (9,840 feet) around the north and west sides of Mount Kibo.

The difficulties increased extraordinarily in this cold wilderness, as Herr Platz fell ill with a severe attack of malaria. As a result of taking this western trip, however, the travelers made an unexpected discovery of three magnificent glaciers on the west side of Mount Kibo. Dr. Meyer climbed the middle one with a negro soldier, while the rest of the party remained behind with Herr Platz, and took up its abode in a huge cave on the Galuma plateau, 12,000 feet above sea level. Dr. Meyer christened the glacier, which he was the first to ascend, the "Drygalski" glacier. He made interesting investigations as to the structure and stratification of the ice and its wonderful formation, besides taking pictures of the moraines. The height of the glacier

INNER SOUTH SIDE OF THE CRATER OF MOUNT KIBO. IN THE BACKGROUND IS SEEN THE ROCKY KAISER WILLIAM PEAK. MASSES OF ICE COVER THE CRATER.

THE WEST SIDE OF MOUNT KIBO, SHOWING THE DRYGALSKI GLACIER.

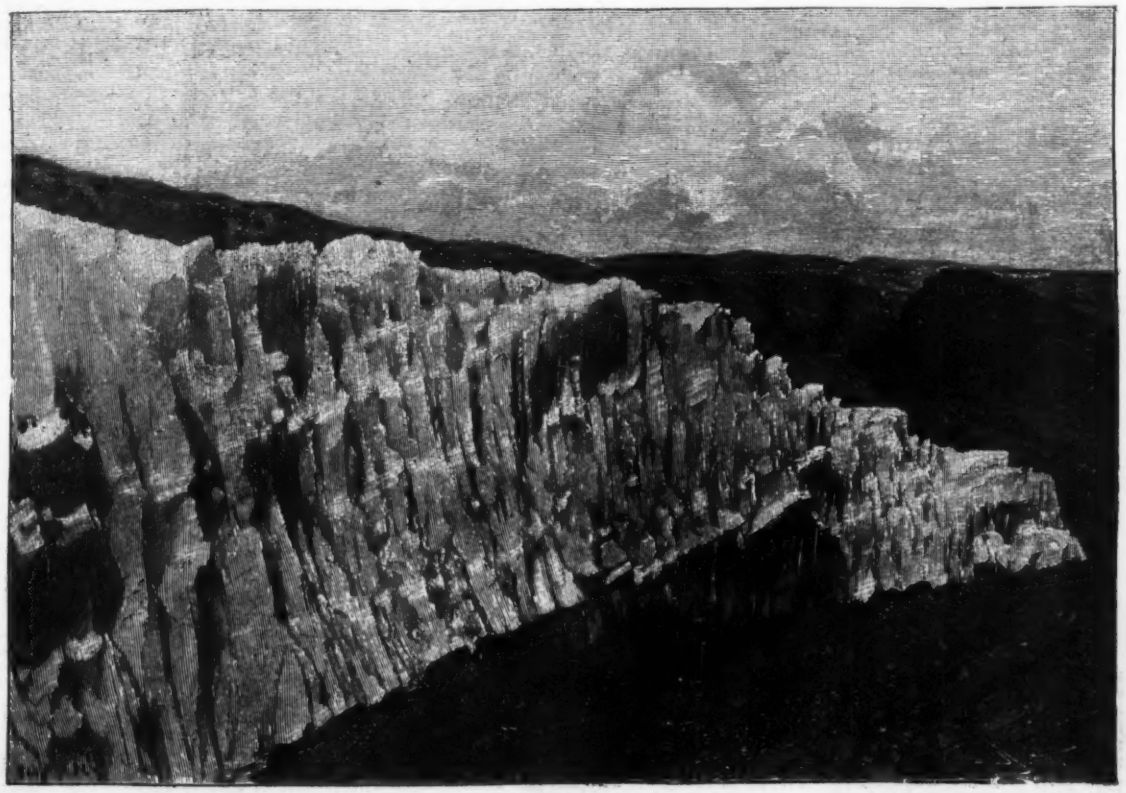
was 15,940 feet. He found the ice was retreating on this side of the mountain, and he noticed particularly an extended, ancient district, where the ice that had melted away had left certain marks, which proved that the west glacier of the Kilimanjaro Mountains had, at some early geological period and in prehistoric times, extended fully 3,280 feet farther down the mountain side than it does at present. According to Dr. Meyer, the huge ravine on the western slope of the range was also formed during the same period. The water has eroded it in such a way that it looks like a magnificent Alpine landscape, filled with high rocky turrets, deep fissures, and steep declivities. Finally, after a mountain trip which had lasted seventeen days, Dr. Meyer descended into the warm, inhabited Dschaggaland, through which he passed, mapping out the western sides of Kibonoto and Madschame, and visiting the flourishing mission here, while he viewed the wonderful landscape of Kiboscho on South Kibo.

He made another ascent into the glacier region of Mount Kibo, the ice field of which appears most extensive upon the south side. This time he was accompanied by Father Rohmer, the priest of the Catholic mission. After four days' arduous climbing, both reached the ice belt, where Hans Meyer discovered no less than four large glaciers. The second one toward the east (15,662 feet high) was ascended, and the appearance and formation of the ice and moraines were carefully investigated. A large melted district was observed, and a wide patch of ground, formerly covered by a glacier, was noticed, showing that the ice, as on the western side of the mountain, once extended more than 3,280 feet further down.

From the former existence of such tremendous glaciers, and from a series of other physical phenomena, Dr. Meyer concludes that East Africa had a glacial period analogous to that of the higher northern and southern latitudes, and that this glacial period is Post-Tertiary, and, therefore, approximately contemporaneous with the Quaternary age of the northern hemisphere.

The return journey to the coast was made by the same route as was taken nine years before, i. e., through British East Africa to Mombassa, in order to compare the development of this colony with that of the German province. The comparison showed the Germans to compare very favorably with the English in colonization. Soon after passing the German-English boundary, the travelers encountered no more roads, bridges, inns, etc.; extensive, sparsely wooded plains, abounding in game, were characteristic of the whole land. Also on the coast no especial improvements have been made since 1889. The whole English province seems to be engaged upon only one work, in which all its energies are concentrated, namely, the Uganda Railroad. The road is already in operation for a distance of about 250 miles, extending from Mombassa far beyond the Kilimanjaro Mountains; in two and a half years more it will be completed to Lake Victoria Nyanza. It is an excellently constructed road, and the trains are comfortable and run very quickly.

Dr. Meyer took the Uganda train at Voi, which is 100 miles distant from Mombassa. The Kilimanjaro range is only a six days' journey from Voi, but it is a very hot and difficult ride over the plains. The road, however, places a Kilimanjaro trip in the range of possibility for a greater public. It is to be hoped that the tiresome journey across the plains and the trouble of the caravan trip will keep "globe trotters" from profaning this beautiful mountain land for a long time to come; but the physical or natural scientist, the geologist, the botanist, ethnologist, etc., will find a much greater attraction than formerly in Africa's wonderful highland world. The explorer in special regions will find remunerative work and great profit



TONGUE OF THE DRYGALSKI GLACIER SURROUNDED BY MORAINES. HEIGHT, 15,940 FEET.

DR. HANS MEYER'S LATEST KILIMANJARO EXPEDITION.

there for an incalculable length of time, though Hans Meyer, in his geographical description of the Kilimanjaro Mountains, may have done most of the discovering.

We are indebted to Illustrirte Zeitung for our description and illustrations.

THE EXPLORING RADIOSCOPE.

ONE of the most important questions in radiography, and one to which but little attention has been paid up to the present, is that of the proper arrangement of the different points of the prints obtained by the new method. If it is a question of searching for foreign bodies in the organism, such arrangement becomes an essential matter.

Reasoning shows, in fact, that it will be possible to register the projection of the image of a foreign body with respect to the contiguous skeletal parts in but a single case, and that is when the foreign body is situated in the perpendicular let fall from the center of emission of the active radiations. In any other position of the tube we shall have an oblique projection, and the image of the foreign body, deviating from the base of the perpendicular, will be projected upon other skeletal parts. Under such circumstances, the reading of a radiograph will necessarily be attended with errors in the surgeon's operation, since he is, naturally, led to look for the object upon a perpendicular erected at the point where its image is formed.

It may therefore be laid down as a principle that a radiograph will not be correct unless the foreign body is situated in the perpendicular let fall from the center of emission. In such a case its different points will be properly arranged and will serve to guide the operator perfectly.

The object of the exploring radioscope which we are about to describe, and which is due to M. Radiguet, is to make such determination with rapidity. On another hand, it leaves upon the limb two register marks that indicate to the surgeon the entrance and exit of an ideal line which necessarily passes through the body sought; and, finally, it permits the operator to know exactly at what depth such body is located, starting from either one of the register marks.

The apparatus (Fig. 1, No. 1) consists of a vertical support, which carries the following pieces:

1. A horizontal arm, *A*, that supports the Crookes tube, which may be moved in all directionss so that it can be centered with respect to the axis of the system, as we shall explain further along.

2. A second horizontal arm, *B*, which carries a metallic ring at its extremity (Fig. 1, No. 3).

3. A third arm, *C*, identical with the preceding. A small platino-cyanide of barium screen, *D*, is mounted upon this arm and permits of examining the images of the two rings or of any other object that may be placed between the latter.

The two upper arms are provided with special markers that end in the center of the two rings (Fig. 1, No. 2), and that are actuated simultaneously by means of pushers, *P* and *P'*, connected by a rigid rod.

When the Crookes tube is set in action, the image of the two rings is perceived upon the screen. As the two arms that carry these are identical, their two centers are found by construction upon the same straight line. Under such circumstances, it is evident that their images can be concentric in but a single case, and that is when the point of emission of the radiations is situated upon the same line as the centers of the two rings. In order to regulate the apparatus, it suffices, therefore, to move the tube until the images of the two rings are concentric. Such a result is obtained in an instant and with the greatest ease. An index movable upon the rod, *A'*, that permits of the lateral shifting of the tube is then rendered immovable so as to register the position of centering of the latter, and so that a return may be made to it without any trouble.

If, now, between the two horizontal arms, we interpose the part containing the foreign body, we shall perceive the latter in any position whatever, with respect to the images of the rings. Upon then displacing the subject under examination or the apparatus itself, we shall bring the image of the foreign body to the center of the two concentric images of the two rings. At this moment it is evident that the foreign body will be located upon the perpendicular. Upon substituting a plate for the screen, we shall be sure of obtaining a properly arranged radiograph.

In order to print the register marks upon the skin, it suffices to cause the two horizontal arms to approach until they come into contact with the limb and then to actuate the markers.

In order to ascertain the depth at which the object is situated, the tube is moved in such a way as notably to displace the image of the foreign body; the new image being an oblique projection. The new position of the foreign body is registered by means of an index, *I*, movable upon the screen. The subject is then removed, and in the perpendicular between the two rings is placed a metric scale formed of wires properly spaced (Fig. 2). This scale is projected upon the screen, and it suffices to observe between what divisions is situated the index that shows the position that

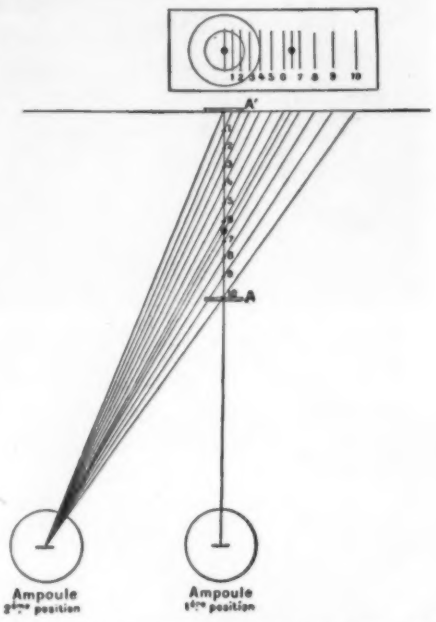


FIG. 2.—DIAGRAM EXPLANATORY OF THE OPERATIONS.

the image of the foreign body occupied. If the scale is divided into millimeters, and it is found that the index is between the sixth and seventh line, it is because the object is situated at a depth of from 6 to 7 millimeters. If the metric scale be placed under the upper arm, we shall have the depth from the upper surface, and, if it be placed above the lower arm, we shall have the depth from the lower surface.

The diagram in Fig. 2 shows the operations as a whole. In the first position, the rays emanating from the Crookes tube meet the two rings, *A* and *A'*, and project their concentric images upon the upper screen, of which we give a plan view.

If, now, we suppose a foreign body to be brought upon the perpendicular, it will form its image in the center of the images of the rings.

When we interpose the metric scale, the divisions of which are figured in section, and the tube occupies the second position, all the divisions will be projected upon the screen along with a second image of the foreign body. If, as in the figure, the latter is between 6 and 7 centimeters of the upper rings, its image will appear between the sixth and seventh divisions.

When the tube is displaced, the images of the two rings are put out of center; but we have not represented such displacement for fear of complicating the figure. This new position of the images of the rings, which is of no utility when a person is making researches upon the screen, will, on the contrary, prove very useful in radiographing in cases in which radioscopy does not permit of a direct examination. In this hypothesis, such images will permit of exactly registering the negative that carries the image of the metric scale.

Upon the whole, these various operations are performed with the greatest ease and rapidity. There is no measuring to be done and no calculation to be made.

Hereafter our apparatus may be employed for researches in all those parts of the human body of which radioscopy now permits an examination. For the thicker parts, such as the cranium, pelvis, and thorax, we shall have to wait until the methods of examination upon the fluorescent screen have reached a greater perfection.

For the above particulars and the illustrations, we are indebted to La Nature.

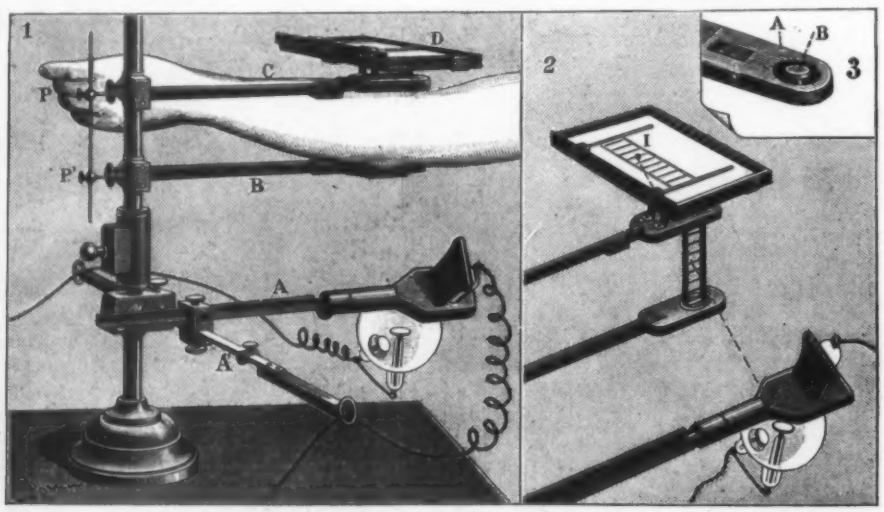


FIG. 1.—THE EXPLORING RADIOSCOPE.

No. 1. *A*, support for Crookes tube; *A'*, bar permitting of the lateral displacement of the tube; *B* and *C*, ring support; *D*, fluorescent screen; *P*, *P'*, pushers. No. 2. Image of the foreign body put out of center. No. 3. *A*, ring; *B*, pad of the marker.

TELEPHONE SERVICE IN FOREIGN COUNTRIES.

A PARLIAMENTARY paper just issued in England containing "Reports Respecting the Telephone Service in Various Foreign Countries" is not only interesting but instructive. These reports, according to The Electrician, London, originated with a request made to the Foreign Office by Mr. A. D. Provand, M.P., that information on these subjects should be obtained by British consuls in the cities of Europe and the United States. After reviewing at considerable length the history of the New York Telephone Company and giving the rates now in force, the telephone systems in Europe are taken up. Italy is the principal country at all resembling New York. Both places are served by private companies, which are the survivors of other companies now defunct or amalgamated, and which hold concessions from the Italian government for 25 years commencing on January 1, 1893. These concessions are, however, subject to cancelation after 12 years on payment as compensation of a sum equal to the average net profit of the three preceding years, multiplied by the number of years which each concession has still to run. If undisturbed for the full 25 years, the plant, lines, and offices become the property of the state. A tax of 10 per cent. is imposed on the gross profits of each concession, free communication with postal and telegraph offices, and a reduction of 30 per cent. in favor of all government, provincial, or municipal offices. On the other hand, the companies possess almost arbitrary powers in respect of way leaves. In Rome and vicinity the concession covers an area including a population of about 500,000. The subscription is 168 lire ($34) annually, with an extra charge for distances exceeding three kilometers. The service is continuous, night and day. Subscribers number 2,102. About 50 women are employed at the central bureau, working seven to eight hours a day, with wages of $6.25 to $10 per month. Workingmen's wages are set down at 40 cents to 80 cents a day, working ten hours. The dividends of the company, which were formerly 3 per cent., are now, under the more secure conditions, 6 per cent. In Florence the same rate of wages prevails, and there is the same continuous service all night and all Sundays. A fortnight's leave of absence is granted annually to the operators and a holiday on each alternate Sunday. The subscription ranges from $32 within 1 kilo to $45 within 3 kilos. There are about 900 subscribers in a population of 250,000. Although the law requires double wires, it has not yet been generally enforced, and single wires are the rule.

Helsingfors, the capital of Finland, is the only other instance reported upon where the telephone service is in the exclusive control of a private company. The same story comes from there as from Italy, several competing companies ending in amalgamation and a joint concession. In the case of Helsingfors, with only 80,000 inhabitants, the company obtained its privileges from the municipality on very easy terms, paying only 1 mark for every wire in the town, but nothing for its 16 trunk wires along the roads. It has 2,800 subscribers. The subscription is from $25 to $27.50 per annum, if the instrument and line are hired, and $17.50 if they are bought. Workmen and female operators receive on an average 75 cents for a day of 10 hours. No information is afforded as to the profits of the undertaking, nor as to the service of any other town in Russia.

Of municipal telephony, the only examples forthcoming are from the Netherlands, Amsterdam and Rotterdam having taken over in 1896 the systems previously worked by private companies and extending in both places to a radius of 3½ English miles. The concession to the municipalities is granted by the state for a period of 25 years, with option of purchase at any earlier period. Full powers are granted in respect of way leaves, except as touching property of the government. The system is double wired, and is a combination of overhead and underground. Amsterdam has a population of 500,000, with subscribers numbering 1,925; Rotterdam a population of 295,000 and 1,320 subscribers. In Amsterdam each subscriber pays $10 entrance fee and $37.50 per annum. In Rotterdam the entrance fee is rather less, and for private (not business) subscribers the rate is $27. The service is continuous night and day. No royalty is paid to the state, the only consideration imposed being the obligation to provide all cable wires for connecting subscribers with telegraph offices and trunk lines—both in the hands of the state. The capital outlay is estimated for each connection at $155 in Amsterdam and $225 in Rotterdam. For the first-named place the receipts and expenditure in 1897 have been published, and will be read with interest. The surplus in that year was $19,800, expenditure being $52,000, against receipts $72,000. A surplus of over $20,000 was estimated for 1898. In Rotterdam the estimate for that year is given as $37,500—interest and redemption of the capital outlay of $320,000 to be defrayed from that amount. The wages in Amsterdam, which appear to be lower than in Rotterdam, are for skilled workmen, $5.50; laborers, $5; working hours, 7 A. M. to 7 P. M. Girl operators are taken on at $1.25 a week, rising to a maximum of $4 a week, working seven hours a day, Sunday and night work (every seventh week) included. Pension for old age or when injured during service and compensation to relatives if killed are fixed by the Rotterdam Municipal Council according to years of service and rate of wages.

We now turn from these solitary instances of municipal control to cases of mixed services—partly governmental, partly private—which are afforded by the much-talked-of systems of Sweden and Norway. Beginning with private associations connecting small towns and villages merely for mutual convenience, telephony had a good start in the country districts be-

fore the dividend-paying concerns were developed in such places as Stockholm; and still more of the government system, which did not come into operation until 1891. In that city the Bell Company started in 1880, the Allmänna Company three years later, and both companies, under a national concession, have exercised powers of way leave greater, probably, than any obtained elsewhere. The competition of the government, commenced in 1891, resulted in the two systems being connected and the double wire being adopted throughout Stockholm. With a population of 271,638, the Stockholm subscribers number 10,369, of which 12,899 belong to the Allmänna Company, 4,506 to the state service, and 1,964 to the Bell Company. It is not clear, however, whether these figures represent separate subscribers or whether any of them subscribe to more than one system. The tariff of the state telephone department only is quoted; but it is presumed that the three competitors' charges are alike, viz., an entrance fee of $13.50, and a similar amount per annum for ordinary business purposes, but $22 per annum if with the right of an unlimited number of calls. Some reduction is made for limited service, and a private telephone may be had for $10 a year, with entrance fee of $2.75. Wages in Stockholm are 70 cents to $1 per ten hours' day. No holidays except Sundays. For the workwomen employed in the exchanges the pay is $12.50 a month.

According to the account received of the Christiania Telephone Company, wages paid by them in that city are even lower than in Stockholm. Rates of subscription for single lines, not exceeding 1,500 meters, connected with the central station, $22 per year; for each additional 500 meters, $2. Extra charges are made for calls in excess of 6,000 a year, and guarantees are required for at least three years' subscription if a new line is required 500 meters from the nearest central station. Christiania has a population of 200,000, of whom 6,475 are subscribers to the company's system. Last year's dividend was 5½ per cent.

There remain to be considered only the purely state telephone systems. Of these, the German and Bavarian have been in government hands from the first, the Swiss also, except for a private venture at Zurich, which was speedily absorbed into the federal system. In Austria-Hungary, as well as in Belgium, the acquisition of the telephone was postponed until 1893 or thereabout, the local undertakings until then being in private hands, although the trunk wires, as well as the telegraphs, were in most instances owned by the state.

In Vienna and Trieste the companies' systems were taken over by the government for a consideration, the amount of which is not stated; but for the connections in Prague, "and everything appertaining thereto," the sum of 1,000,000 florins was paid by the imperial government. The Vienna system extends over an area of 69 square miles, 70 per cent. of the wires being double, the remaining 30 per cent. single. The population numbers 1,400,000. At the time of the transfer there were 7,700 subscribers, which in 1897 had increased to 10,573. Within a radius of 1¼ miles from the central exchanges the subscription is $2 per annum. At these central exchanges the service is continuous throughout the day and night. The female attendants are paid from $12.50 to $17.50 a month; laborers, 50 cents to 75 cents a day. Trieste, with 163,979 inhabitants, has 1,020 subscribers. Capital outlay per wire is estimated at about $85, the average length being about 1,255 meters. The general circumstances are the same as in Vienna. Prague has a population of 320,805, the subscribers to telephone exchanges numbering 2,200. The initial tax is 50 florins for the first 500 meters and an annual subscription of 50 florins. Wages are about the same as in Vienna. In the Prague report mention is made that "telegrams destined for subscribers on the exchange are telephoned to them;" also that subscribers may telephone their telegrams to the post office for transmission by telegraph.

In Belgium the concessions to private companies expired in 1893, when the telephone systems came under government control. Such, at least, was the case at Ghent, for which alone particulars on this point are given in the report. Ghent, with its surrounding districts, has a population of 200,000. The subscribers number 900, but whether this is in Ghent proper is not quite clear.

In Switzerland the telephone system has been worked by the federal government since 1881 and is considered very popular. Berne, with a population of 53,000, has 2,025 subscribers; Zurich has 157,000 inhabitants, with 4,400 subscribers; Geneva has 3,264 subscribers out of a population numbering 58,700. The underground cables are of double wire throughout; the overhead, as a rule, single wire. The tariff rates are the same all over Switzerland, namely, $20 and $14 for the first two years respectively and $8 for succeeding years, a charge of one halfpenny being made for each communication, "thus proportioning the expense to the use made of the telephone." Workmen's wages range from 75 cents to 85 cents a day of ten hours. Those of the women operators from $240 to $360 a year, their working day being seven to eight hours in winter and eight to nine hours in summer. Once in fifteen days they take night duty, the service being continuous.

From Bavaria reports have been received relating to Munich, Stuttgart, and Wurtemberg; also from Frankfort, Cologne, Hamburg, Leipsic, and Berlin, all of which are, of course, under the Imperial German Telegraph Administration. The conditions, therefore, are pretty uniform, resembling those in the city of Berlin, and need not be particularized. It is worth noting, however, that mention is made in the Munich report that the female operators are required to be of good education and able to "transcribe and translate without serious mistakes at French or English dictation." Probably this rule applies to all Germany and to other countries—Switzerland, for example—as well. Down to February, 1898, the tariff had undergone no change, and the rumor alluded to by Mr. Provand that the Berlin telephone system yielded 14 per cent. profit was described as premature.

The area of Berlin and suburbs, including Potsdam, has a population of 2,314,451, of which 28,785 are subscribers to the telephone service. It has nine principal exchanges, each arranged for 5,000 to 6,000 subscribers, and 35 public stations, besides 95 at stock exchanges. By means of its trunk wires, the capital is in communication with about 350 large towns, both within and without the boundaries of the empire. The system is described as single wire throughout, each connection averaging 1·9 kilometers. The chief features of the tariff are:

(a) For each telephone erected within the district of the city telephone system, and not more than 5 kilometers (as the crow flies) from the central exchange, an annual rent of $37.50 (150 marks).

(b) For each telephone beyond the above limit, the distance within which connection is possible being decided by the imperial post office, for every 100 meters of additional wire, or part of that length, beyond the 5 kilometer limit, an additional annual payment of 3 marks.

For messages accepted to be transmitted by telegraph, a general charge of 2½ cents is made and ¼ of a cent for each word. For three minutes' conversation on the trunk wires, the following examples may be given: With Prague, 50 cents; with Amsterdam, Copenhagen, Rotterdam, and Vienna, 75 cents; Budapest, $1. Exchanges are open from 7 A. M. to 10 P. M. Night service between two subscribers can be arranged for by an extra charge of $2 quarterly. Capital charge for each wire is estimated at $110. Female telephone clerks are employed at the telephone bureaus and have the position of officials. They receive a daily wage of 55 cents to 75 cents, according to length of service, and they perform Sunday duty in turn. The girls have to be of good education and able to pass an examination. Workmen employed on the telephone lines receive 75 cents to $1.10 a day. The Berlin report concludes with the following remark, which is applicable to the whole of the German imperial telephone service:

"No statistics can be given relative to the financial position, as in consequence of the union of the postal, telegraph, and telephone systems under one administration, the revenue and expenditure are reckoned under one head, and separate data do not exist. The introduction of a different system of charges is in contemplation, but it is not known if the tariff will be lowered in consequence."

Frankfort-on-Main, with a population of 229,279, has 3,909 subscribers; Leipsic (398,448) has 4,294 subscribers; Cologne (321,564) has 3,784 subscribers; Hamburg city proper has 625,552 inhabitants, of whom 12,064 subscribe to the local telephone system. The service is installed for one year certain, with three months' notice after the end of the first year.

MAMMOTH IVORY.

By R. LYDEKKER.

IN spite of all their ingenuity and skill, there are two animal products of high commercial value which our manufacturers have nothitherto imitated with such success as to make the substitutes equivalent in utility and beauty to the originals. These products are elephant ivory and whalebone, and although the imitations in the former case make a much nearer approach to the true article than has been found practicable in the latter, they still leave much to be desired. Consequently, the demand for natural ivory is not only likely to be maintained on the same level as heretofore, but would undoubtedly increase if an adequate supply were forthcoming.

True ivory, to which the name should properly be restricted, is the constituent of the tusks of elephants of different species, and is found in no other animals. In making this statement it must not be assumed that its presence in mastodons is denied, since those extinct animals are nothing more than elephants in a wider sense of the term. From other so-called ivory, such as that of hippopotamus tusks, sperm whale teeth, and narwhal "horns," elephant ivory is readily distinguished at a glance by the "engine-turned" pattern—similar to that on the back of a watch case—which it displays in cross-section, as may be seen by looking at the butt end of the handle of a table knife. And it is probably due to this peculiarity of internal structure that elephant ivory displays the elasticity which forms one of its most valuable properties.

As all the readers of this journal are doubtless aware, there are only two living species of elephants at the present day, namely, the Indian, or, as it might with more propriety be called, Asiatic, and the African. As regards the production of ivory, the latter is, or perhaps was, much the more valuable animal of the two. In the first place, till within the last few years, it existed in almost incredible numbers in many parts of its habitat; and in the second place it produced more ivory, animal for animal, this being due to the circumstance that whereas in the African species both sexes are furnished with tusks of large size, in its Asiatic cousin they are generally restricted to the male sex, and even then in certain cases may be but very poorly developed.

Again, it appears that in modern times, at all events, much of the ivory yielded by the Asiatic elephant is worked up in the land of its birth, comparatively little reaching Europe in the raw state. Consequently, for recent ivory, the European market is very largely dependent upon the product of the African species, for which the great commercial emporia are London and Antwerp. Now, although, a few years ago, elephant hunting was a profitable trade in the remoter districts of southeast Africa, the herds have been so reduced in number that comparatively little ivory is obtained at the present day. Moreover, the great stocks of ivory formerly possessed by the native chiefs have been largely reduced or exhausted over the greater portion of the country. It is true, indeed, that in the Congo district elephants are still locally abundant, while the opening up of the Egyptian Soudan may very probably introduce to the market a supply of tusks from Kordofan, Dafur, and the Bahr-el-Gazal districts. But if these regions prove productive in ivory, it is only too likely, unless proper precautions are taken, that they will comparatively soon be shot out. And if the production be not placed under restriction, it is evident that the annual supply will be relatively small.

It is clear, therefore, that African ivory is likely to become gradually scarcer and scarcer; and if there were no other source of supply this beautiful substance would apparently soon reach a prohibitive price.

As a matter of fact there exists, however, in the frozen tundras of Siberia a supply of ivory which will probably suffice for the world's consumption for many years to come.

This ivory is the product of the mammoth (Elephas primigenius), a species nearly allied to the Indian elephant, but protected from the cold of the Arctic regions by a coat of long, coarse hair, with a finer woolly underfur at the base. The tusks, too, of the mammoth were larger and more curved than those of its living Asiatic relative, being sometimes twisted into a spiral almost recalling that formed by the horns of the African kudu. From the abundance of these tusks it is further probable that they were developed in both sexes.

In addition to dwelling on the Arctic tundras of the Lena, Yenisei, and Obi valleys, as well as extending to the New Siberian Islands (which in past times evidently formed a portion of the Asiatic mainland), and Alaska, the mammoth roamed over a large portion of Europe in Pleistocene times. And in the gravels and brick earths of our English river valleys its tusks, teeth, and bones are of comparatively common occurrence; while quantities of similar remains are dredged from the Dogger bank by the North Sea trawlers. If, however, the ivory turner expected to find a workable commodity in British mammoth tusks, he would be grievously disappointed. All those found in the gravels and brick earths, as well as the specimens hauled up from the Dogger bank, have lost the greater part of their animal matter, in consequence of which they crumble more or less completely to pieces when exposed to the influence of the atmosphere, and for the purpose of preservation and exhibition have to be copiously treated with size or gelatine.

Not so the mammoth ivory of the Siberian tundras, which, in the best preserved specimens, retains the whole of the original animal matter, and, except when stained by earthy infiltrations, is as suitable for the purposes of the turner as the best product of the African elephant. This remarkable state of preservation has been produced by entombment in the frozen soil of the tundras. In many instances, as is well known, entire carcasses of the mammoth have been found thus buried, with the hair, skin, and flesh as fresh as in frozen New Zealand sheep in the hold of a steamer. And sleigh dogs, as well as Yakuts themselves, have often made a hearty meal on mammoth flesh thousands of years old. In instances like these it is evident that the mammoths must have been buried and frozen almost immediately after death; but as the majority of the tusks appear to be met with in an isolated condition, often heaped one atop of another, it would seem that the carcasses were often broken up by being carried down the rivers before their final entombment. Even then, however, the burial, or at least the freezing, must have taken place comparatively quickly, as exposure in their ordinary condition would speedily deteriorate the quality of the ivory.

The retention of their animal matter and their unaltered condition have led some writers to object to the application of the term fossil to the Siberian mammoth tusks and to restrict its use to the altered and partially petrified specimens met in the superficial deposits of warmer countries. This, however, is quite illogical, seeing that a fossil must be defined as including the remains or traces of any animal or vegetable buried in the earth by natural causes. And we may, therefore, with perfect propriety speak of the Siberian mammoth tusks as fossil, in contradistinction to petrified, ivory.

How the mammoths were enabled to exist in a region where their remains became so speedily frozen, and how such vast quantities of these became accumulated in certain spots, are questions which do not at present seem capable of being satisfactorily answered; and their discussion would accordingly be useless, not to say out of place, on the present occasion. It will suffice to say that such accumulations do exist, and that the soil of certain portions of the tundras seems to be almost crammed with such remains.

It may, however, be remarked that the contents of the stomachs of the frozen mammoths, as also those of the two species of rhinoceroses which were their fellow inhabitants of the tundras, contain remains of pine needles and other vegetable substances. And from this it may be inferred that the tundras themselves were clothed with forest during the mammoth epoch; since the theory that the carcasses were carried down by the rivers flowing from warmer southern regions into the Arctic Ocean can scarcely merit serious attention. Possibly some light may be thrown upon the subject by the great accumulations of bones of large recent mammals which have been met with in certain districts of East Africa.

Although outside scientific and commercial circles comparatively little is known with regard to the subject in England, mammoth ivory, in place of being a modern discovery, was known to the ancients, and has for centuries been an article of trade and manufacture. It is, however only recently that the history of the subject has been worked out; and for this we are largely indebted to the labors of Sir H. H. Howorth,* and Dr. Trouessart,† of Paris. Baron Nordenskiold has likewise contributed important information on the subject in the "Voyage of the Vega." And it is from these sources that the following paragraphs are mainly compiled.

If we may take the "buried ivory" mentioned by Pliny on the authority of Theophrastus, a disciple of Aristotle, to be the same as mammoth ivory, we may regard this substance as known to the western world in the time of Alexander. But apart from this, mammoth ivory was evidently familiar at a very remote time to the Chinese, who spoke of the animal by which it was yielded as "thien-shu," the mouse that hides. This mythical creature, which was compared in size to an elephant, was reported to lead a subterranean existence like a mole, with bones as white as ivory, and the flesh cold, but pure and wholesome. This reference to the coldness of the flesh apparently pointing to their acquaintance with frozen mammoth carcasses.

In Europe, Eginhard, the historian of Charlemagne, states that among the presents sent to the Emperor of the West by the Kalif Haroun-al-Raschid in the year 807 were the horn of a "licorne" and the claw of a griffon. These rarities were long preserved in the royal treasury at St. Denis; and, from a description given in a work dated 1646, it appears that while the former was a mammoth tusk, the latter was the horn of the woolly Siberian rhinoceros.

During the ninth or tenth century‡ Arab traders

* "The Mammoth and the Flood," Chap. III. (1887).

† "Le Mammoth et l'Ivroire de Siberie," Bull. Soc. Acclim. Paris, 1892

‡ Dr. Trouessart gives the former, and Sir H. Howorth the latter.

appear to have established a trade-route from Northern Russia or Siberia to Persia or Syria; and their records refer to the occurrence of buried ivory near the city of Bolghari, on the Volga, which was probably situated on or near the site of the modern Nijni-Novgorod. The first Siberian mammoth tusk imported into Western Europe in modern times was brought to London in the year 1611 by one Josias Logan, by whom it had been purchased from the Samoyedes of the Pechora district. Concerning this specimen, Baron Nordenskiöld writes that as Englishmen at that time visited Moscow frequently, and for long periods, a remark occurring in Purchas's history appears to indicate that fossil ivory first became known in the capital of Russia some time after the conquest of Siberia.

Be this as it may, it is in evidence from the account of Avril, who traveled in Russia during 1685, that fossil ivory was at that time imported into China and other Asiatic countries where it was highly esteemed; and it is stated that it was largely employed by Turks and Persians for ornamenting sword and dagger hilts, being preferred to Indian ivory on account of its whiter color and finer grain. And here it may be incidentally mentioned that, according to the same author, the Russian term mammout is a corruption of the Hebrew behemot, or behemoth, which the Arabs make mehemot. Canon Tristram is, however, of opinion that in the Bible behemoth often refers to the hippopotamus; and, if this be correct, a transference of the name would appear to have been made by the Arabs, this being the less improbable since it is stated in Hebrew to be applicable to any large beast.

Apart from this there is a record that about 1722 Peter the Great ordered the collection of tusks and other remains of the mammoth for the museum at St. Petersburg. And between 1750 and 1770 a Russian trader named Liakhoff established an extensive importation of mammoth ivory from the districts lying between the Khotanga and Anadyr rivers, and likewise from one of the southernmost islands of the New Siberian group, which still bears his own name. Surveys subsequently made by the government in those islands indicated that the soil is teeming with the bones, tusks, and teeth of mammoths; while the adjacent mudbanks exposed at low tide are equally prolific. Some idea of their abundance may be gathered from the account given by Dr. Bunge, who visited Liakhoff Island from 1882 to 1884, and in the course of three short summers collected no less than two thousand five hundred selected specimens. In the New Siberian Islands the thermometer now often falls to fifty degrees Centigrade below freezing point, so that collecting is an impossibility during the winter.

With regard to the amount of mammoth ivory that comes into the market, accounts are by no means so numerous nor so accurate as might be desired. It is stated, however, that in 1821 a Yakut brought back five hundred puds (forty pounds to the pud) from the New Siberian Islands; and between the years 1825 and 1831 the amount annually sold in Yakutsk ranged between one thousand five hundred and two thousand pud, in addition to that disposed of at other towns. Many writers speak of seeing boat-loads of tusks on the Lena and Yenisei—a steamer which carried Baron Nordenskiöld in 1875 having a cargo of over one hundred. About the year 1840, Dr. Middendorff, who visited the country, estimated that the annual output of Siberian ivory reached one hundred and ten thousand pounds, representing at least a hundred individual mammoths; so that the total number of animals whose remains have been exported since the conquest of Siberia must be between twenty thousand and thirty thousand. And since Middendorff's estimate probably errs on the side of being too low, the numbers may have been considerably in excess of this.

In the London market, according to Mr. Westendarp, one thousand six hundred and thirty-five mammoth tusks were sold during the year 1872, and one thousand one hundred and forty in the following year; the weight of these varying from one hundred and forty to one hundred and sixty pounds each. Only a small percentage of these were, however, fit for the turner of ivory of high quality; about fourteen per cent. being of the best description, seventeen per cent. of inferior quality but still useful, while fifty-four per cent. were bad, and the remaining fifteen per cent. rotten and worthless.

According to Dr. Trouessart, the price of mammoth ivory in the market at Yakutsk is twenty-five francs per pud for the highest quality, seventeen and a half francs for the second, and from five to seven francs for the third quality. A small quantity is worked up locally into ornamental and fancy articles of various kinds; but this industry seems to be a waning one, and more and more of the raw material goes direct to the foreign market. Yakutsk, which is situated on the Lena about midway between its mouth and the frontier of China, and has about five thousand inhabitants, has long been the acknowledged center of the trade; but it is considered probable that at present the great bulk of the ivory goes to China, and that only a comparatively small portion finds its way into the more distant markets of Europe. The opening up of the country by the Siberian railway may, however, lead to a revolution in this respect, and also inaugurate a new era of prosperity for Yakutsk and the other Siberian towns.

With regard to the future development of the trade and the persistence of the supply, it may be remarked that only a small portion of Siberia has hitherto been explored at all, and that other deposits remain to be discovered. Of those already worked, Dr. Trouessart writes as follows: "It is difficult to believe that the enormous quantity of tusks indicated by the masses of bones spoken of by travelers who have visited the archipelagos of Northern Siberia can have been accumulated in the course of only a few centuries. It is most probable that only the surface of these vast bone deposits has hitherto been exploited, and that by excavating the soil to a greater depth, and, if necessary, employing the aid of dynamite to break up the frozen strata, good results will be obtained.

"If this idea be well founded, and if, as is unfortunately only too probable, the supply of African ivory comes practically to an end at no very distant date, there is every hope of finding a precious reserve in the fossil ivory of Siberia."—Knowledge.

THE PREPARATORY WORK IN GRAPEVINE CULTURE.

IF soil in which vines have been already grown is to be planted anew, then, besides trench-digging, no other labor is necessary than plowing, the making of terraces, waterways, paths, and walls, and the provision of means for irrigation and drainage. The hardest work is encountered in woody slopes and in forest

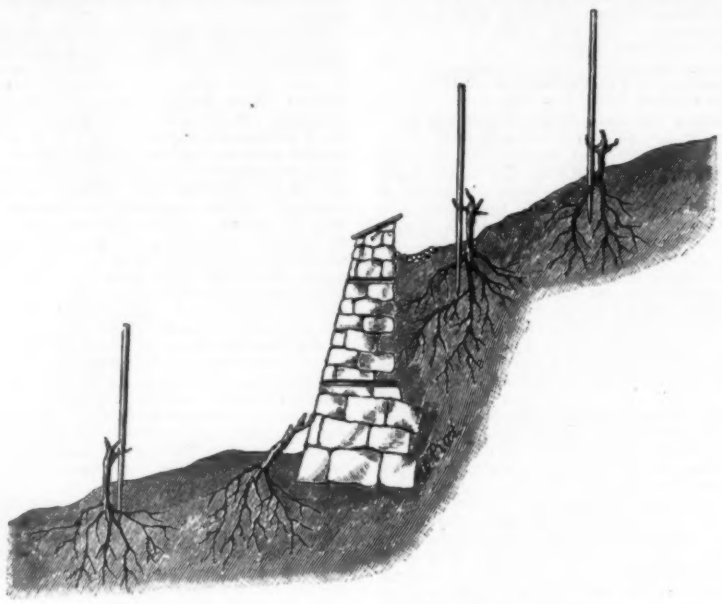


FIG. 1.—SECTION OF A TERRACE-WALL.

ground. The tilling of such land often requires an expense of labor hardly commensurate with the returns. Work of this character is most easily performed on level land, especially if the soil be uniform.

Paths have usually been provided, but in large vineyards, and particularly in virgin soil, especial attention must be paid to the making of roads, for they must serve for the transportation of manure and garden refuse and as a means for turning the plows. A breadth of two to three meters (2·18 to 3·27 yards), according to the size of the carts or barrows used, is, therefore, not too great. In steep slopes such paths are placed only at the foot of the incline, or rise therefrom obliquely. If the hill be not too steep, paths can be made which run parallel with the foot of

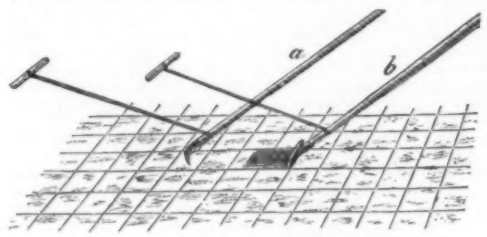


FIG. 2.—SOD-CUTTING TOOLS.

the hill, and which serve to a certain extent to connect points of the same height. Such paths require only an inclination sufficient to permit drainage. The paths on the slopes must not be too steep, otherwise they would fail in their purpose. If a hill be high and steep, it is usually very unprofitable to make spiral paths; the installment of a hoisting apparatus would be considerably cheaper.

On steep ground terraces must be built in order to render possible the cultivation of vines. The erection of terrace walls is, however, too costly to be carried out under the present wages paid. If stone happens to be on the spot, and if only a few walls are to be built, then the work, despite its cost, will prove profitable.

While the side of the terrace facing the hill must

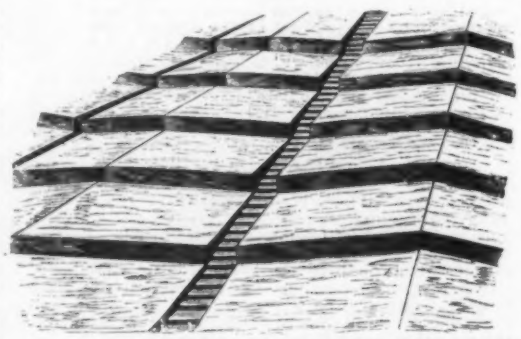


FIG. 3.—TERRACE FORMATIONS.

rise slightly, the side away from the hill must be more inclined, in order to be able to resist the pressure of the wet masses of earth. The crevices which always remain in such dry walls serve as drains for the water which accumulates. If the rains be very heavy, then, as shown in Fig. 1, a channel is made behind the upper portion of the wall, to conduct the water to any suitable place. The moisture which slowly trickles through flows partly through the water conduits seen in the wall and partly through the crevices between the stone work. These crevices, in time, become clogged. The upper course of stones is best formed of inclined broad, flat stones, in order to prevent a crumbling away of the wall. Often flat stones of such size cannot be obtained. In such cases either a layer of sod is employed, or the upper stones are embedded in mortar. The erection of stone walls is usually avoided, the same end being attained by steep slopes of earth planted with grass or bushes to prevent the earth from sliding down. These slopes can be sodded only if they are sufficiently moist, for otherwise the grass would dry up in summer.

In cutting sod an ordinary spade is used, but the work cannot be so uniformly done as with regular sod-cutting tools. In Fig. 2 such implements are represented. The sod-cutter shown in Fig. 2*a* is a knife sharpened at its foward convex edge and secured to a long handle which can be pulled by a chain. In cutting sod with this knife, a long straight rod is used as a kind of gage, the knife being guided at the proper depth along the edge of the board. After cutting two

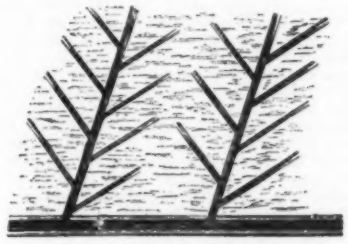


FIG. 4.—DRAINAGE-SYSTEM.

series of equidistant parallel lines at right angles to each other, a number of squares are formed which are severed from the ground by means of the share shown in Fig. 2*b*.

The slope can be covered either with the sods thus cut, or a regular sod wall can be built. The first can be done when the slope is not steep and the soil firm; the second can be accomplished when the slope is very steep and the soil loose and sandy. Sod walls are formed very much like brick walls, the sod being cut rather thickly, and the intermediate spaces filled with earth.

If sod cannot be obtained, then the steep slopes are planted, preferably with bushes. For this purpose the plants are set in rows 80 cm. to 1½ meters apart, at equal heights parallel with the foot of the slope. The roots penetrate the soil horizontally, while the plants shoot up vertically and form a dense, earth-protecting wall.

Fig. 3 shows the method of terracing a vineyard, the steps being made to serve as waterfalls. At the upper edge of the wall (Fig. 1), paved tributary channels run, which collect the water from the individual terraces, and lead it to the steps. These waterways have only a slight fall; and a large part of the earth washed away

FIG. 5.—THREE TYPES OF DRAIN.

from the terrace collects in such channels. Such mud being often good fertile soil should be used over again in the vineyard.

If a slope is to be drained, it is usually necessary only to lead away the water from the springs, which can be done by means of the rain water gutters already at hand. Upon level ground, the making of drains is more difficult. If the swampy tract be large, a verit-

able net of drains will have to be dug. It is advantageous to make the channels so deep that they cannot be reached by the larger roots of the vines.

Such a drainage system, as already remarked, comprises a network of gutters (Fig. 4), in which are included main channels and tributary channels. The main channels, on account of their size, are usually exposed; while the others run underneath the soil. If the subsoil be loose, and if it conduct the water well, only main channels need be provided, which must be at least 1½ to 2 meters (1·63 to 2·13 yards) deep.

The ordinary clay conduits cannot be used in vineyards, because the deeper roots easily penetrate them,

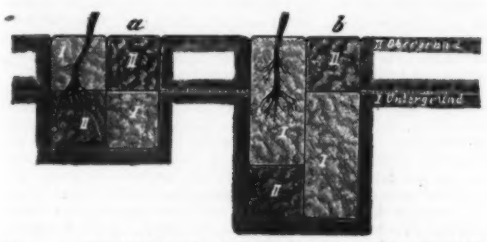


FIG. 6.—TRENCHES CORRECTLY AND INCORRECTLY MADE.

and by reason of the moisture develop so rapidly that they would choke up the pipes. Instead of such conduits, channels of stone or wood are used. Fig. 5*a* represents a stone gutter, whose bed is ¼ meter (1·64 feet) wide and 2 meters (6·56 feet) below the surface. The largest stones are laid on the bottom and sides; while the roof is formed of flat stones upon which is placed a layer of small stones covered with sod, moss, and the like, so that the earth cannot clog the intermediate spaces. If flat stones cannot be obtained, then horizontally disposed wooden braces (Fig. 5*b*) should be employed. If no stones at all are to be had, crossed wooden braces (Fig. 5*c*), upon which is laid the brushwood, should take their place.

Another work which must be undertaken before

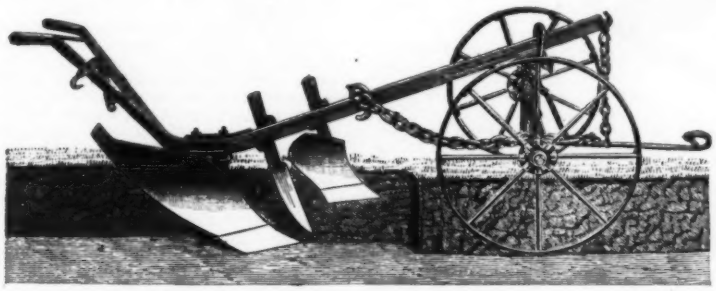


FIG. 7.—TRENCH-PLOW.

trench-digging is the leveling of the soil. If the inequalities in the ground be great, such labor is to be avoided, owing to the expense incurred. If the soil is to be cultivated by hand, no attention need be paid to the inequalities. It is true that a hilly vineyard is not pleasant to look upon; and every amateur, in spite of the small return, should endeavor to level his vineyard so far as he possibly can.

The grape is one of those cultivated plants which has a most extensive system of roots. It is, therefore, of prime importance to every grower that the soil be deeply cultivated and thoroughly loosened. Well-loosened soil not only gives full play to the growth of the roots and facilitates their nourishment, but by reason of its sponginess absorbs considerable moisture. Such a systematic cultivation has for its object not only the loosening of the earth, but also the improvement of the soil, and often earth of small value can thereby be converted into a soil of high quality. The chief consideration before the digging of trenches is a tho-

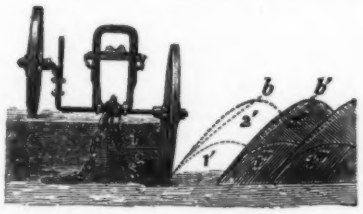


FIG. 8.—METHOD OF FORMING TRENCHES.

rough knowledge of the subsoil. As to the depth to which the soil should be dug, opinions differ; but as a general rule the depth depends largely upon the fertility, the nature of the crust and of the subsoil, and the climatic conditions of the country.

The trenches should never be dug too deep, otherwise the young roots would not reach the lower fertile layers of earth and would grow but poorly in the sterile subsoil. It is, therefore, necessary that the roots should penetrate to the fertile earth layers, for which reason the barren soil brought up from below should not be too large in quantity.

Fig. 6 shows how the soil is treated according to the previously-mentioned method. In Fig. 6*a* the earth has been dug to the proper depth and the roots just reach the deep, fertile layers; but the condition illustrated in Fig. 6*b* is less favorable, because, owing to the great depth to which the soil has been dug, the fertile layers are not reached.

Trench-digging by hand is a costly proceeding, especially in large vineyards. Trench-digging by plow is more readily performed, and is employed by most large growers. To be sure, plows can never penetrate to depths of one meter (3·28 feet) and over; and if it be desired to protect the vines from summer dryness, then recourse must be had to hand labor. In fertile soil, where deep digging seems superfluous, plowing is to be preferred, since depths of 50 to 60 centimeters can be easily reached. Such soil should not be too loamy or stony.

In Fig. 7 a plow used in trench-digging is represented. The front share when properly adjusted deposits a layer of soil in the bottom of the furrow (Fig. 8). The knife or colter behind the share serves to facilitate the work of the plow in the rear. This colter cuts off the furrow and at the same time clears away such obstacles as stones, pieces of wood, and the like. The main plow has to perform the most work, for it throws up the subsoil, 2 (Fig. 8), and deposits it upon the crust. Such a plow is usually drawn by from three to five horses or oxen and penetrates the soil 50 centimeters, so that the height of the furrow is 60 to 65 centimeters (23·40 to 25·35 inches). If a greater height be desired, a gang of men behind the plow can increase this depth to 75 centimeters (29·25 inches); if it be desired merely to loosen the subsoil, then a subsoil plow (Fig. 9) can be run through the furrow to a depth of 30 centimeters (11·70 inches).

If larger areas are to be furrowed, then it is more advisable to employ steam power. If there be a lack of animals and of steam plows, then a horse-driven winding-drum and cable can be used, as shown in Fig. 10. The four small wheels upon which the winding-mechanism is mounted run on rails, so that the drum can keep up with the progress of the work.

After plowing, the soil is, of course, uneven. These inequalities can be removed either immediately or after the completion of the work. In order to break up the earth thoroughly, the ground is gone over with a sharp, weighted harrow. The soil can then be left

FIG. 10.—POWER-DRIVEN TRENCH-PLOW.

for planting in the spring to the favorable influences of air, cold, and water.—M. dal Paiz, in Stein der Weisen.

FIG. 9.—SUBSOIL-PLOW.

THE GRAND CANON OF THE COLORADO.

By RALPH S. TARR, Professor of Physical Geography in Cornell University.

IT is remarkable how few people visit this, the most wonderful bit of scenery in the world. Many traveling Americans do not even know of its existence, and many pass within 72 miles of it without taking the trouble to stop over a few days in order to see the cañon. This is chiefly because the Atchison, Topeka & Santa Fé Railroad, which passes nearest the cañon, has never properly advertised it.

In order to reach the Grand Cañon, one stops at Flagstaff, Arizona, reaching there in the morning too late to take the stage trip. If tired of traveling, this gives a good opportunity for rest before the long stage ride of the next day. Most people will take the afternoon for a journey to the cliff dwellings near by, which are easily reached in a short drive. There, under the overhanging cliffs, are found a score or two of stone houses, interesting remains of the prehistoric cliff dwellers, whose rather high state of development is indicated by the bits of quaintly marked pottery strewn about in front of the houses.

At 7 o'clock the next morning (the stage runs every other day) the stage leaves Flagstaff, making the journey of 72 miles in 12 hours, using four different teams for the trip. For the most part the journey is through a beautiful pine forest and the weather delightfully cool; for over a large part of the distance the elevation is above 8,000 feet.

Flagstaff, a typical Arizona town, lies nestled at the base of the San Francisco Mountains, which rise 14,000 feet above sea level. The central peak is one of the numerous recent volcanoes of the West. It is a conical pile of lava with a large crater at the top, and for a long distance the stage road runs over the lava that has been thrown out from this crater.

After passing to the western base of this extinct volcano there appear in view a number of tiny cones, perhaps a score or two in all. They are black and barren looking, and so perfect in form that one easily recognizes them as volcano cones. The craters are almost as they were left when the last eruption died out; and some of the lava flows look so fresh that one might almost imagine that they had come to the surface during the last century. None of these secondary cones are very high, and, in fact, most of them are mere hills: but their number is surprising, and they are of interest as silent witnesses of the former volcanic energy which in recent geological time has disturbed so much of the western region.

Leaving these hills the stage road passes over the plateau, descending into arid plains, passing to lower levels and reaching the forests again when rising into the cooler and damper upper parts of the plateau. It is a region of buttes and mesas, and the scenery is ever changing and usually pleasant.

At one point the road winds in and out through a small cañon with a wall of lava on one side and of limestone on the other. The driver calls attention to this remarkable feature, and many go away without finding the true explanation of it. While the driver says that there is lava always on one side and limestone on the other, closer observation shows that the lava is resting on the limestone, which appears in places beneath it. What has really happened here is that the lava flow has extended out over an irregular land surface, filling a valley partly full of the molten rock. The present stream is now forming a cañon between limestone and lava, thus revealing the contact and excavating the buried hills and valleys.

To the person who has read much about the Colorado Cañon the temptation is irresistible to go directly from the stage to the edge of the plateau and look down into the Grand Cañon immediately upon arriving at the journey's end. It is but a few yards from the tent "hotel," and, if the sun is shining, one finds it well worth while to go there and look down into that awful chasm, carved and sculptured beyond description, and see the giant peaks and frightful ravines cast into deep shadow by the late afternoon sun.

Some resist this temptation and postpone their visit until after supper and then take their first view of this wonderful valley when it is lighted up by the setting sun. Perhaps this is the wisest course, for first impressions are most lasting, and, although no impression of the Grand Cañon can possibly disappoint, it is perhaps better to gain as favorable a first impression as possible.

The Colorado Cañon is a river valley, carved in the high plateau of Utah and Arizona by the Colorado River. It is fed mainly from the snows of the mountains of Colorado. This gives it a fairly permanent water supply, though, of course, more comes at some times than at other times.

The river then flows across an arid country until it reaches the sea in the exceedingly hot and dry region of Southern California. With permanent water supply and great original slope the Colorado has been able to carve a cañon in the high plateau for a distance of more than 300 miles. Throughout its entire distance it receives but little addition from the tributaries which enter from either side, for these carry little or no water during most of the time. However, when a cloud burst falls upon them, they are transformed temporarily to raging torrents.

The rocks through which the river has cut are chiefly nearly horizontal sheets of strata of ancient Paleozoic beds, older than the coal measures. There are sandstone, limestone and shale, layer upon layer, over 6,000 feet of them being revealed in that part of the cañon reached by the stage. These layers are variously colored, gray, white, red, yellow, and many other tints.

From the cliffs at the edge of the cañon near the "hotel," one looks down into a great chasm in the earth, and there in the distance, nestled at the foot of frowning cliffs, is seen the river itself, so far away, and

so far below, that in the distance it looks like a tiny thread of silver in the various colored landscape of sculptured cliffs. One cannot hear the roar of the torrent that courses madly down the bottom of the cañon, still busily engaged in deepening it by the same processes that were employed in its formation.

For a score or two of miles one looks up or down the cañon, while the view directly across to the opposite wall covers a distance of at least ten or twelve miles. The rain and the rain-born streams have sculptured this valley fantastically. There are hundreds of side valleys with projecting points of the plateau, or with isolated plateau topped hills or buttes between. Through the center extends the Grand Cañon itself; but there are scores of great side cañons, in themselves wonderful, but here lost by blending into a mere minor part of the grand scene; and then there are tens of thousands of still minor valleys, each forming a mere minute detail in the great result.

While of course the most impressive feature is the immense depth, one is also powerfully impressed by the variety of form, and in this connection is struck by the remarkable control over form and color exercised by the rock strata themselves. Being quite nearly horizontal, these layers extend at fairly uniform levels along both walls of the cañon, as well as upon the projecting points and hills. Since these layers are differently colored, there are nearly horizontal bands of color in the cañon; but through the distortion of perspective resulting from the projection of parts of the cañon walls, there is not that rigidity which would appear if there were merely parallel bands of color upon parallel valley walls.

Not only are there bands of color, but also of form; for some layers are hard and others soft, so that some stand up boldly as precipices, often quite inaccessible for heights of hundreds of feet, while others have moderately steep slopes because they are less resistant and hence unable to stand up as cliffs. This gives marked variety to the cañon form.

In the arid lands there is a certain angularity of topography and a barrenness that are not pleasing. Here in the Colorado River region there is also a notable absence of vegetation on the cañon walls; and here also the same angularity is noticed because the same cause is present; but the grandeur, the variety of color, and the immense variety in form necessarily present in such an extensive region of sculpturing, counteract the impression of angularity so completely that one is scarcely aware of its presence.

As one stands upon the edge of the cañon looking down into the deep trench in the earth, so great that in the region under view a score of Niagara gorges could be placed in such a position as to be completely hidden from sight, the eye wanders up and down over a wonderfully beautiful and varied panorama. No words can adequately describe the sight and no brush will ever completely represent it on canvas. Each spot contains something that causes the eye to linger, and at no two times does it look the same. The shadows change, the colors assume new tints, a cloud casts a shadow over a part of the cañon, or possibly a thunder storm crosses a portion of it, vividly showing how immense the cañon is; but the sunset in the cañon is the climax, and once seen will never be forgotten.

The geologist sees more than the beauty and grandeur. There before him are thousands of feet of rock layers formed in the sea by the slow processes of deposition, and requiring for their accumulation a time so great that whole races of animals came and went, leaving only their fossils as proof of their former existence. Not only is all this time recorded here, but down near the bottom of the cañon, underneath these horizontal layers, are seen others still older. These layers had been folded and formed with mountains and had then been worn down to irregular hills before the horizontal strata were deposited in the ocean. The contact between this ancient buried land surface and the ocean-formed rocks is very distinctly seen on the trail to the bottom of the cañon.

This means that rocks were formed, then folded into mountains, then worn down to hills, then lowered beneath the sea, then covered with a depth of certainly not less than 5,000 feet of ocean sediment. This is a wonderful history; but it did not end here. Once more the region was elevated to be dry land and a river allowed to flow across it and to commence its immense task of cañon formation. Now by slow action year after year it has cut so deeply into the earth that it has reached the buried mountains nearly a mile below the surface and has cut into their very core at a depth of over a mile below the general plateau level. Nowhere in all the world can the geologist obtain in a single glance such an impressive lesson in geology; and the layman may well stop to ponder over it and to grasp its significance.

As the result of a great deal of hard work a trail has been kept open by Mr. Hance, so that the visitors may make the journey to the bottom of the cañon, which is well worth doing, for, notwithstanding the fact that one is strongly impressed with the immensity of the cut made by the river, even when looking into it from above, it is true that one must go down to the river side in order to fully grasp this. One must see the immense cliffs frowning down upon him from the height of a mile, and must see what have appeared from above to be tiny hills grow in size until they become veritable mountains, in order to fully realize what it is that he has been looking at. After this one should make another visit to the rim of the cañon so as to see again, with enlarged powers of appreciation, the region through which he traveled the day before.

The journey to the bottom of the cañon requires about a day; and, although most of it is easily done upon mule back, the average traveler finds himself tired at the day's end. Many interesting things are seen, but perhaps the most interesting of all is the change in climate. From the cool, forest-clad plateau one descends into a rock-rimmed cañon which, with every step, grows more oppressively arid. A difference of from 20 to 40 degrees is noticed in temperature in passing down to the bottom of the cañon, and the heat is rendered more oppressive because of the fact that winds are not frequent in the inclosed space between the narrow cañon walls. Mr. Hance spends his winters in the bottom of the cañon; and, while the plateau a few miles away is snow covered, the climate in the bottom of the cañon is warm and summerlike.

The visitor to the Colorado Cañon should read Powell's "Cañons of the Colorado" and his "Exploration of the Colorado Cañon;" and, if interested in geology, Captain Dutton's "The Grand Cañon," a beautifully illustrated and interestingly written description of the geology and scenery of the cañon region. Major Powell made the first journey through the cañon, passing by boat from the upper to the lower end. Few bits of travel were more bravely planned and executed or more interestingly described than Powell's difficult and dangerous journey. It is a most fascinating bit of description, but seems to be known to only a few. Among American travels it should stand out with almost as much prominence as does the Colorado Cañon itself among American river valleys.—The Independent.

THE RHINOPITHECI.

AMONG the regions of the globe that have been but incompletely explored, one of those that presents the most interest to the naturalist is certainly the region

FIG. 1.—SNOW MONKEY OF MOUPIN (RHINOPITHECUS BIETI)—MALE.

that extends along the confines of China, Thibet, and Indo-China, and that comprises Setchuan or Szetchouen, Moupin, Kansou, and Northern Yun-nan. Along with species possessing a European physiognomy and along with Chinese or Malaisian species that seem to have ascended the course of the Hoangho or Yellow River, of the Yang-tse-Kiang or Blue River, of the Mekong, or of the Salouen, we find here some very curious animals the existence of which has been revealed to us by the successive explorations of Abbé Armand David, Gen. Przewalski, the brothers Grum-Grzimailo, M. Bonvalot, and Prince Henri d'Orleans, and by the researches of the French missionaries Mgr. Biet and the Reverend Fathers Soulié, Dejean, Genestier, and others.

In the month of November of the year 1868, Abbé David, who had already traversed the other provinces of the Celestial Empire in all directions, decided to undertake a new voyage to Setchuan and Thibet. After ascending the Yang-tse-Kiang in a Chinese junk,

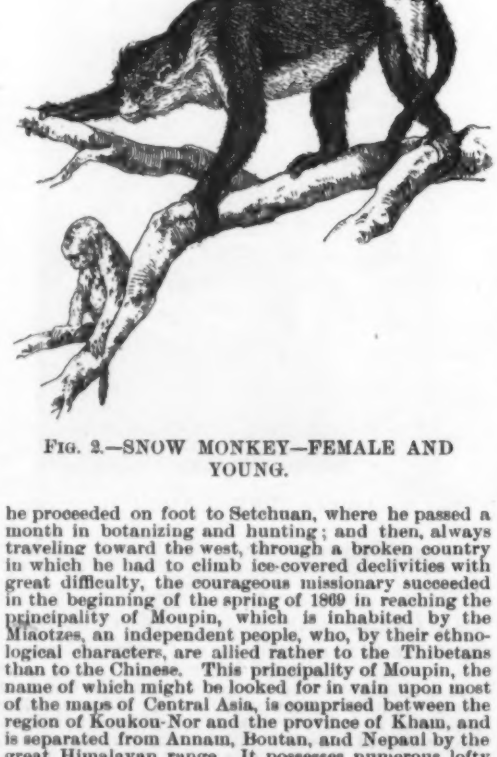


FIG. 2.—SNOW MONKEY—FEMALE AND YOUNG.

he proceeded on foot to Setchuan, where he passed a month in botanizing and hunting; and then, always traveling toward the west, through a broken country in which he had to climb ice-covered declivities with great difficulty, the courageous missionary succeeded in the beginning of the spring of 1869 in reaching the principality of Moupin, which is inhabited by the Miaotzes, an independent people, who, by their ethnological characters, are allied rather to the Thibetans than to the Chinese. This principality of Moupin, the name of which might be looked for in vain upon most of the maps of Central Asia, is comprised between the region of Koukou-Nor and the province of Kham, and is separated from Annam, Boutan, and Nepaul by the great Himalayan range. It possesses numerous lofty mountains, of which the Hong-chan-tin, which rises to 5,000 meters, is not one of the highest. So, although the center of Moupin is situated between the 31st and 32d degrees of north latitude, that is to say, is at the same level as Egypt, the winters are extremely severe. The snow lasts for several months, even in the valleys, and during the rest of the year there are very frequent rains. Such continual humidity of the atmosphere favors a rich vegetation. Everywhere are found growing magnolias, laurels, and rhododendrons, which often attain a large size; and the mountains, up to an altitude of 3,000 or 4,000 meters, are covered with magnificent forests of pines and cedars. It was in this country, up till then completely unknown to Europeans, that Abbé David established himself in the center of a great valley at more than 2,000 meters above the level of the sea and at but one day's journey from Hong-chan-tin Mountain. It is here that, with the assistance of the hunters of the country, but not without very great difficulty, he procured a large number of mammals and birds belonging to groups that no one expected to see represented in these elevated regions.

Among the mammals discovered in Moupin one of the most interesting is the snub-nosed monkey, discovered by Milne-Edwards under the name of Rhinopithecus Roxellanæ. This species inhabits the mountains of the western part of Moupin and the neighboring districts, as far as to Koukou-Nor. It consequently lives in a region in which the snow lasts for half of the year. According to the accounts of hunters, the Rhinopitheci gather in numerous troops in the forest, usually remain upon the highest branches of the lofty trees, and feed upon fruit and the buds of bamboos. By the absence of cheek pouches as well as by the conformation of their molar teeth, the Rhinopitheci offer affinities with the monkeys of India and Indo-China, which have a long tail and hair of bright color and which are called Semnopitheci; but they differ from these in their shorter limbs with stronger muscles, in their posterior hands provided with a more highly developed thumb, in their face with less prominent jaws and a snub nose, and in their more intelligent physiognomy.

The Roxellan Rhinopitheci attain a considerable size, and, at an adult age, measure nearly a meter and a half to the tip of the tail. They are clothed with a coat of quite thick fur, which is somewhat hirsute and of a color that varies from dark gray to golden tawny and ruddy; so the natives call this species kin-tsin-heou, which means "golden-brown monkey." They hunt for it with great eagerness in order to obtain its skin, which is held in high estimation for the cure of rheumatism.

In the same country, Abbé David met with some macacos (Macacus tibetanus, Milne-Edwards) allied to the famous baboons of Gibraltar, but of more robust form and a more elongated face; and from information gathered from some Chinese, who had traveled to the south of the Yang-tse-Kiang, he made known the presence in this region (at least during summer) of large, long-tailed, black monkeys, coming from the country of the Miaotzes. So, in the course of his trip from Tonkin to Bengal, Prince Henri d'Orleans endeavored to procure some of these monkeys, which he had seen at Batang in a preceding voyage, and which Mgr. Biet informed him were to be found in the vicinity of Tsekou; but, since the season was not favorable, he did not succeed in obtaining any specimens. Being obliged to continue his journey, he had to be content to leave subsidies, weapons and ammunition with Father Soulié.

Owing to these resources, and the data furnished by M. Biet, it was possible to organize hunting parties in the forests that cover the western slope of the chain which separates the valley of the Mekong from that of the Blue River. This led to the capture of a large number of mammals and birds, which Father Soulié sent to the Paris Museum of Natural History, and among which there were seven specimens of both sexes, old and young, of the large monkey previously made known by Abbé David. M. Milne-Edwards immediately recognized the fact that it was a Rhinopithecus belonging to a new species, which he named Rhinopithecus Bieti, and soon afterward described and figured in the Bulletin of the Museum.*

Biet's Rhinopithecus is larger and more robust than Roxellan's, and, while resembling the latter in general conformation, notably differs therefrom in the color of its coat. In the adult male, the shoulders and back are covered with a thick fur formed of long hairs of a bluish gray, bordering upon grayish black at the extremity, and interspersed with a sort of silk of greater length and of a brilliant yellowish gray.

Upon the external surface of the limbs, the fur becomes shorter, and, upon the feet and hands, changes to a brillaint black; but upon the thighs there are wide patches of curly white hairs forming a fringe behind and resembling in color that of the lower parts of the body. The latter, in fact, are like the throat, chin and sides of the head, covered with white hairs which, upon the cheeks, become elongated into whiskers that nearly conceal the ears. This white beard offers a marked contrast with a sort of coif of a dark gray that reaches nearly to the eyes and from the center of which rises a crest of long recurved hairs. The eyes, which are very small, are encircled by a band of bare skin of a livid color, while in Roxellan's Rhinopithecus this region is of a pale blue or turquoise green. Finally, the tail is covered with thick frizzled hairs like those of the dog called the griffon.

In the female, which is much smaller than the male, the color is nearly the same, but the crest is not so high, the white post-femoral hairs do not form so developed a fringe, and the hairs of the tail are not frizzled. In its native country, this animal is called the snow-monkey and Tchru-tchra.

For the above particulars and the engravings, we are indebted to Le Magasin Pittoresque.

According to Mr. J. Sterling in the "Transactions" of the Australasian Institute of Mining Engineers, observations taken in Lansell's 180 Mine at Bendigo show increases of temperature in depth as below: At 454 feet 1° F. for each 110 feet; at 1,294 feet 1° for each 182 feet; at 1,750 feet 1° for each 173 feet; at 2,295 feet 1° for each 152 feet; at 2,701 feet 1° for each 137 feet; at 3,110 feet 1° for each 110 feet; at 3,250 feet 1° for each 111 feet. The mean result of these ratios shows that the ratio of 1° F. for every 137 feet in depth is the record of the Silurian rocks of Bendigo.—Engineering and Mining Journal.

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* 1897, No. 5, page 157.

ENGINEERING NOTES.

The Imperial Canal Commission of Germany are so impressed with the strategic importance of inland waterways that the canals of that country gain increased importance in the eyes of the military authorities, who remember the difficulties they had with the railroads during the Franco-Prussian war.

According to a French contemporary, while American engineers do not utilize falls of less than 80 cm. (2½ feet) for driving turbines, their French colleagues turn to account falls of even 10 cm. (4 inches) because at Maquens, near Carcassonne, a "turbinette" working with this slight column of water develops a power of 9 kgs., raising the water to the height of 35 m.; and at Aix-en-Savoie water is raised to the height of 55 m. (180 feet) with an available fall of only 25 cm. (10 inches). At Toulouse a turbine working with a column of 50 cm. yields a force of 15 horse power. In order to obtain good results, all that is required is to arrange that the turbine be constantly under water.

Reports of canal commerce at Sault Ste. Marie (both Canadian and United States canals, representing the entire freight movement to and from Lake Superior) show a total of 2,908,068 net tons of freight moved east and west to June 1, this year, as against 3,372,374 tons on the same date a year ago. The decrease of 464,279 tons is not large in view of the late opening of navigation and the Buffalo freight handlers' strike. The mineral freight items compare as follows:

	1897.	1898.	1899.
Copper	23,984	26,790	10,833
Iron ore	890,305	1,834,595	1,619,294
Coal, bituminous	339,389	576,009	317,201
Coal, anthracite	52,960	62,821	128,789

Of the total freight this year, 2,365,806 tons were east bound and 542,262 tons west bound.—Engineering and Mining Journal.

The launch of half a ship at Newcastle-on-Tyne recently was one of the most remarkable feats in shipbuilding annals. It will be remembered that the "Milwaukee" went ashore in Cruden Bay, near Aberdeen, last September, and it was found that a large rock had pierced her hull. In the old-fashioned way the wrecked vessel would have been left to the mercy of the North Sea waves, and quickly battered to pieces. Up-to-date salvors, however, do not abandon their patients so easily. After a survey, it was decided that the case was not quite so hopeless as it seemed, although it was evident that the whole ship could not possibly be saved. But half a ship was better than no ship at all. Dynamite was brought into play, and the "Milwaukee" blown in two. The most damaged end, the fore part, was left to its fate; but the after part was made watertight and successfully towed into the Tyne, where it soon will be re-wedded to its new and presumably "better half."

The "Holland" submarine boat is to have her final test by the government in a short time, for the purpose of deciding definitely whether the strange craft shall or shall not be adopted by the Navy Department for use in warfare. Representatives of the company owning the "Holland" boat have notified Secretary Long that they are ready at any time now for the test, and the Secretary of the Navy has signified his intention to set a date for the trial, which will be held at Peconic Bay, Long Island. It will be a different test from any of those yet undergone by the submarine boat, and will determine practically her value as a destroyer. The chief claim of the inventor has always been that the boat could approach an enemy's ship unseen and destroy it. In all tests heretofore the "Holland" has contented itself with a dummy torpedo, but in Peconic Bay a real Whitehead torpedo will be fired at a target, and on the ability of the boat to hit the mark and destroy it will rest her chance of becoming one of the vessels of the United States.

An interesting experiment is about to take place on the Clyde which, in view of all that has been said as to the superiority of American tools, must be regarded as of great importance. It is nothing less than a really exhaustive trial of the compressed air tools which are used in some of the leading shipbuilding yards of the United States. The tools are not only for riveting, but there are others for chipping and calking, as to the practicability of which doubts have already been expressed, but which should be withheld till after the trials. At the same time, shipbuilders are likely to require complete evidence as to the convenient installation of the necessary compressed air plant in their particular yards, for the satisfactory working of Mr. Rowan's electric riveter in some of the works of the Clyde has led to the hope of further developments in that direction, where no extra machinery would be required, as electric lighting is now the common illuminant in shipbuilding yards. According to The Glasgow Herald, a staff of skilled workmen from the United States is coming over with the tools, so that their efficiency will be tried under most favorable and satisfactory conditions.

The alloys of the metals of the platinum group have become very important since we have learned that some of them, like platin-iridium, are eminently fitted for making electric resistances, with the help of which the most delicate measurements can be conducted, and, further, thermo-couples and other apparatus. Some of these alloys must be regarded as definite chemical compounds, but it is not often possible to isolate their crystals. In preparing these alloys, the one metal acts as solvent for the other and also for the alloy. From a paper read by Fr. Rossler, we see that alloys of platinum or palladium on the one side, and bismuth or antimony on the other, have been isolated. They have the formula $Pt\,Bi_3$, etc.; Rossler also found a $Pt\,As_2$ accidentally. The bismuth or antimony is melted, 2 per cent. of platinum is added, and the compound is extracted with acids. The alloy $Rh\,Bi_4$ was prepared from a 5 per cent. rhodium solution, extracted with nitric acid. When gold is mixed with 1 per cent. of rhodium, the whole mass afterward dissolves in aqua regia. When more rhodium is present, the acid again takes up the same percentage of rhodium. Some of the originally amorphous rhodium, however, appears afterward in feathery crystals of the pure metal.

SELECTED FORMULÆ.

In order to make sail cloth waterproof, we start with a fine soap, which is prepared in the following way: Soft soap is boiled in water until it has completely dissolved. About half the weight of fine vitriol is now added under continued boiling. The soap floats on the top and hardens to a white cake, which must several times be remelted in boiling water in order to get rid of the potassium sulphate. We now prepare our linseed oil. It is boiled with a little potash and a little water, when it assumes a soap-like condition. We then add acetate of lead, litharge and minium in small quantities, and also resin, boiling, but taking care not to let the temperature rise above 100° C. The fine soap is put in under continued boiling. When the soap has dissolved, we finally add rubber and oil of turpentine, stirring well. This is the solution we paint the cloth with several times; the solution must be kept at a temperature of 70° C. After the first coat has been put on, the cloth is dried while hanging; then follows the second application, which, as a rule, will suffice for waterproofing.

A new process for waterproofing textiles is composed of a solution of aluminum, prepared in the usual manner from aluminum sulphate and sugar of lead. To this a solution of tannic acid dissolved in water is added, and the salting fluid is then ready for use. A preparation in paste form, preserved for an indefinite time, is obtained, says an American contemporary, by adding tannic acid to a solution of sulphate of alumina, to which a definite portion of sodium carbonate has been added. The precipitate that forms may be dissolved in acetic acid when wanted for use. Nothing is said as to the water-repelling property of cloth prepared by this means, or whether it has any other effect upon the fabric.

Cleansing Compounds.—The liquid cleansers used for removing grease from gloves are, as a rule, composed principally of benzine with very small quantities of chloroform and ether added together with a sufficient amount of some volatile oils to give the mixture an agreeable odor. Such a mixture is the following:

Benzine	100	ounces.
Chloroform	4	"
Ether	½	"
Oil of bergamot	30	drops.

Tincture of soap bark has also been recommended in the following combination:

Tincture of soap bark	6	ounces.
Ether	8	"
Spirit of ammonia	1	"
Oil of lavender	3	drachms.
Benzine	50	ounces.

For cleansing clothing, an entirely different class of preparations has become popular under the names of "lightning cream," "lightning renovator," etc., which consist of solutions of castile soap in mixtures of alcohol, water, chloroform, ammonia, etc., there being some slight difference in the formulas preferred by different pharmacists. The general method of preparation consists of cutting the soap into fine shavings, dissolving this in a portion of the water by the aid of heat, allowing to cool, mixing the other ingredients with the remainder of the water, and finally mixing the two solutions. We present several formulas here which may be taken as types of this class. If desired, chloroform may be substituted for the ether:

1.

Glycerin	1	ounces.
Ether	1	"
Alcohol	1	"
Ammonia water	4	"
Castile soap	1	"
Water enough to make	32	"

To 16 fluid ounces of water add in the following order the glycerine, ammonia, and ether. Shake and add enough water to measure 32 fluid ounces. Then add the soap in shavings and shape until dissolved.

2.

Castile soap	2	ounces.
Borax	2	"
Soap liniment	3	"
Alcohol	5	"
Ammonia water	8	"
Water, boiling	96	"

3.

Castile soap	2	ounces.
Sodium carbonate	1	"
Borax	½	"
Ammonia water	4	"
Alcohol	2	"
Ether	1	"
Water enough to make	64	"

—American Druggist.

A German patent has been granted for the treatment of articles of plaster of Paris with an aqueous solution of ammonium borate for the purpose of hardening them and rendering them insoluble in water. A simple and efficient process for accomplishing this object would be highly desirable, as it would serve to greatly prolong the life of plaster casts, which, being quite soft and not entirely insoluble, sooner or later become superficially defaced, and washing especially wears down the outlines of the object. The process above referred to is said to give results decidedly superior to anything that has heretofore been proposed. The hardening liquid may either be mingled with the plaster in the act of molding, or may be applied on the surface of the finished casts with a brush. The solution is prepared by dissolving boracic acid in warm water and adding thereto sufficient ammonia to form the borate which remains in the solution. The manner of using the solution is thus described: The saturation of the gypsum or painting of the plaster of Paris is carried out in the cold. The objects are subsequently rinsed off and dried. The surface becomes very hard after two days and insoluble in water, while the induration in the interior advances more slowly. By means of the fluid described gypsum floors can be hardened and rendered more durable and impervious to the influence of the weather. Saturating with ammonium borate is said to be especially useful on exterior walls of buildings, barracks, etc., on the latter, because experiments have proved an antiseptic action of the liquid.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Copper and Brass in Japan.—Consul-General Gowey writes from Yokohama, under date of April 24, 1899, to a Pittsburg company:

The customs returns show that during the year 1898 there were imported into Japan 224,941 pounds of copper plates, sheets, and rods, valued at $29,243, and 93,925 pounds of yellow-metal sheathing, valued at $9,970. What proportion of rods were included in the foregoing the returns do not indicate.

Under the heading of exports, copper sheets and plates do not appear; but of refined copper there were shipped abroad during last year 35,709,650 pounds, mostly in the shape of slabs and ingots, valued at $3,553,245. Exports of manufactures of brass, at the same time, were valued at $9,856.

The efforts made to produce sheet copper in Japan, I am informed, have not been encouraging, and the press has lately reported the failure of one of the largest concerns in this line of trade at Osaka. Japanese copper, while of fine appearance, has produced much dissatisfaction as sheathing on vessels—salt water destroying it in a very short time. An American vessel was sheathed at this port with Osaka copper purchased from a prominent Tokyo firm during the past year, and in about two months thereafter the metal was discovered to be entirely eaten through in so many places that its removal was made necessary, and Muntz metal substituted.

For the latter article, or its equivalent, there is undoubtedly a growing market in the Orient.

The American Trading Company and the China and Japan Trading Company at this port can doubtless furnish more precise details concerning the trade in these metals.

Trade Openings in British Columbia.—Vancouver is the most important distributing point for merchandise, machinery, and articles in general that are brought to this province for use or consumption. While a very considerable portion of the articles used in British Columbia is imported from the United States, I believe, says United States Consul L. E. Dudley, of Vancouver, that a much larger part could be secured to the merchants and manufacturers on the southern side of the border if their wares were pushed in this market with more energy than they are at present.

If a number of merchants would combine together, secure a suitable place in this city, exhibit their samples, and take orders, a large increase in the sale of American products would, I believe, result. There should also be connected with the establishment two or three traveling salesmen, to make frequent visits to all important points in the province, introducing the articles, quoting prices, soliciting orders, and giving information relative to tariff duties, freights, etc.

Such an establishment could be maintained at a cost which would fall very lightly on each contributor if a considerable number of persons or firms united in the enterprise. There is a demand here for—

(1) Food supplies of all kinds, embracing breadstuffs, groceries, fruits, etc.

(2) Household, store, and office furniture, including desks, tables, chairs, parlor and bedroom furniture, carpets, etc.

(3) Hardware, consisting of shelf hardware, builders' hardware, hand tools, nails, bolts, screws, stoves, tinware, and all that goes with such lines.

(4) Machinery for mining and milling purposes, for use in construction of sawmills, canneries, pulp and paper mills, etc.

(5) Glass and glassware, including plate glass, mirrors, table glassware, show cases, lamps, etc.

(6) Electrical apparatus for street cars, motors, lights, etc.

(7) Instruments for use of surgeons, assayers, prospectors, surveyors, etc.

(8) Explosives, for use in mining, etc.

(9) Opticians' wares.

(10) Hydraulic mining machinery.

(11) Ship chandlery.

(12) Bicycles, typewriters, etc.

(13) Stationery.

(14) Paper for printing, newspaper, book, and correspondence.

(15) Printers' supplies.

(16) Tin plate is used in very large quantities for making cans for salmon.

(17) Clothing and boots and shoes.

I have mentioned paper and pulp mill supplies. There are at present no such mills in this province, but material for the use of such mills is abundant. The demand for paper of all kinds is considerable, and there seems to be a good opening for some enterprising "Yankee" to establish these mills.

I have received more than one hundred catalogues from manufacturers in the United States. These catalogues cover a very wide range of production. They are kept on file in this consulate, open to the inspection of all persons interested. Their influence, however, would be much more satisfactory if an energetic salesman could circulate among the business men, explaining and quoting prices, etc.

I shall be glad to receive inquiries from interested persons regarding the subject of this article and shall esteem it a privilege, as well as a duty, to aid any who desire to enter upon such an enterprise as I have suggested.

Cultivation of Tobacco in the Philippines.—I have noticed, says U. S. Consul Wildman, of Hong Kong, that the American newspapers generally have taken what seemed to me an unusual amount of interest in a report on "Tobacco in the Philippines," published in the Consular Reports of March, 1899. Since then, I have obtained additional information on this subject, which I trust will be received as supplementary to what I have already written. In the first report I noted that a representative of the Dutch and English tobacco growers of what is known as the Sumatra leaf had passed through this city en route for northern Luzon, where he was to test the soil regarding the possibility of the introduction of Sumatra tobacco.

During the past week, a Mr. Velge, who for years has lived in northern Luzon in the employ of the Oriente Tobacco Company, arrived in this city from Aparri. Aparri is the port in northern Luzon from which the bulk of the Manila tobacco crop is shipped to the great

factories in Manila. Mr. Velge (an Englishman) informs me that he has already thoroughly tested the soil with great success regarding the growth of Sumatra tobacco, and has conclusively proved that its introduction is practicable. Mr. Velge had previously been engaged in tobacco planting in Sumatra, where the soil would produce a crop only once in seven or eight years. In the experiments he made in the provinces of Cagayan, Isabela, and New Biscay, he found that the soil would grow a crop every year, producing a leaf 15 inches in length. It was even ascertained that the new soil was too rich, and that the old soil that had been under cultivation for some years produced a thinner and stronger leaf. Although the experiments were so eminently successful, the wholesale cultivation of the Sumatra leaf was never undertaken because of the obstructive policy of the Spanish régime. Mr. Velge estimates that one acre of this ground will produce from six to ten thousand plants, or trees as they are technically termed. One native is considered capable of planting and harvesting an acre. He is paid for his services in the cultivation of Manila tobacco about $10 Mexican for every 100 pounds of tobacco that is accepted by the warehouses. This means an income for him throughout the year of about 25 cents Mexican per diem.

Of course, at the date of writing there is almost nothing being done in the tobacco-raising provinces, as the ports are closed and their markets are shut off. Men with money who are on the ground when the country is thrown open and life and property are safe can realize large returns by investing in these rich tobacco lands; also in laying a railroad line through them from Aparri south.

Embroidery School at Plauen.—Consul Monaghan, of Chemnitz, under date of April 15, 1899, reports that a school for teaching embroidery is about to be opened in Plauen. The government has appropriated 9,000 marks ($2,142) and the city 3,000 marks ($714) for the initial expenses; 5,000 marks ($1,190) and 3,000 marks ($714), respectively, will be contributed annually for its maintenance. The number of applicants for admission is said to be so large that hardly half can be accommodated. Consul Monaghan speaks of the excellent system of technical education in Germany; nearly every important branch of industry in the empire, he says, has its school, and the country's industrial development is in large measure due to these educational facilities.

Knife Shields in Germany.—Consul Brodowski writes from Solingen, April 22, 1899:

Millions of knives, razors, etc., are manufactured in this consular district, and the material for the shields is imported from all parts of the world, to the value of tens of thousands of dollars monthly. Any kind of hard wood (walnut excepted), bones of horses and other large animals, deer and buffalo horns, ebony, etc., are used. Cuban ebony and hard woods are preferred, and it seems in general that the American imports give the most satisfaction. A good deal has been lately imported from the Chicago stock yards. The largest firms in this branch here are Wilhelm Fluekt and Carl Schürmann. I believe that I could do a good deal to further our export trade in this direction, if fair offers were made to importers here.

New Venezuelan Tariff.—Minister Loomis writes from Caracas, under date of May 22, 1899:

The Venezuelan Congress, which adjourned on Saturday last, enacted a new tariff law; but owing to the numerous amendments made to the original bill, it is not possible for me to get a corrected copy for transmission by this mail. It can be said, however, that there will be an average increase of 25 per cent. on existing duties, a very few articles—flour among them—being excepted. In addition to the advance in duties made by the new law, power is given the President to add 25 per cent. more to any or all of the new schedules, as he may see fit. In short, the new law makes it possible for the President to regulate the tariff pretty much as he deems best. The new duties will probably not be imposed for sixty or seventy days. No date, I think, has been fixed for putting the tariff into effect.

Steamship Service Between Singapore and the Philippines.—Consul-General Pratt, of Singapore, under date of April 19, 1899, transmits to the department copy of a letter addressed by him to General Otis, at Manila, in which he states that upon relinquishing his position in the consular service he contemplates the establishment of a line of steamers under the American flag, to ply between Singapore and the different ports of the Philippines, especially the southern ones, which can be reached with special facility by way of British North Borneo. Such a line of steamers, of sufficiently light draught to enter the shallower island harbors, would, Mr. Pratt thinks, be useful for the transportation of troops and supplies. The boats would, in the first place, be at the disposal of the government, and serve, secondarily, for the convenience of the public.

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The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

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